

Spatial Patterns and Their Innovation in Urban Design: Theoretical Inquiry and Practice for New-Quality Development

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Abstract. Spatial production is a critical component in the development of new-quality productive forces. As an internal mechanism of spatial production, the spatial pattern has considerable theoretical significance for fostering new-quality spatial productivity. By clarifying the concept of spatial patterns and systematizing their formative factors, this paper argues that the core of innovation in urban design lies in pattern innovation: the creative recombination of existing spatial elements. It then identifies the underlying logic of such innovation in the attributes of elements and the organization of relationships, and distills eight prototypical schemas: stripe, concentric ring, grid, patchwork, archipelago, linear form, boundary, and unit. This approach moves beyond the morphological understanding of conventional urban design and marks a methodological shift from shaping spatial form to configuring spatial patterns. Drawing on design practices and case studies, the paper further explains how these prototypes operate in application, with the aim of opening an alternative theoretical discourse for urban design.

Keywords: urban design; spatial pattern; pattern innovation; prototypical schema; new-quality spatial productivity.

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Innovation is central to the national strategy of developing new-quality productive forces: scientific and technological advances generate new industries, new models, and new drivers of growth, while the innovative allocation of factors of production is one of their principal sources. Spatial production is no exception. It must adapt to, and mutually reinforce, changes in productive factors, emerging production scenarios, and new relations of production if it is to provide efficient, high-capacity spatial carriers, enabling conditions, and policy instruments for new-quality development. How to construct new-quality spaces, or mechanisms of spatial production oriented toward new quality, and how to theorize them as generally applicable methods for urban spatial research and practice have therefore become defining questions for planning and design. While many scholars have addressed this emerging agenda [1-2], innovation in spatial patterns, as a core concern of urban design, offers a response at the level of both principle and method.

1 Spatial Patterns

1.1 Essential Meaning of Spatial Patterns

1.1.1 Conceptual Definition

In urban and rural planning, the term “spatial pattern” is used broadly across overlapping contexts of spatial organization, governance, development, and operation. This paper returns the concept to the ontology of design. A spatial pattern is defined here as a relational model and graphic schema abstracted from the generative mechanism and compositional logic of a given spatial type, such as an industrial park, university, cultural center, transport hub, or residential district. In concise terms, it is a typological organization of spatial elements.

A pattern mediates between form and paradigm. Form is the materialization of a pattern and is constructed progressively from it; a paradigm is established and consolidated through repeated pattern innovations that share the same or a similar orientation, as in the transition from externally organized to self-organized design. Spatial patterns therefore belong to the methodological core of urban design. They are general, structural, stable, and translatable, and apply across scales from the macro to the micro. Their central concern is the strategy and effect of organizing spatial relationships, including relations of production

and social relations that correspond to particular historical periods, populations, forms of capital, policies, and technologies.

The central business district (CBD), for example, is a building-economy pattern derived from the dense agglomeration of multinational corporations for the global production and consumption of information by financial capital under neoliberal competition. Each skyscraper represents an individual unit of capital, while their homogeneous juxtaposition creates an apparently equal field in which capital enters the world market and performs its identity. The standardization and rapid reproducibility of this pattern made it a spatial vehicle of finance-led globalization, and countless cities adopted it as an emblem of prosperity. The same applies to transit-oriented development (TOD), work-unit compounds, and commodity-housing estates: through distinctive spatial organizations, they influenced or even determined the forms of production, everyday life, and social structure of particular periods and regions. As the material organization of a mechanism of spatial production, a spatial pattern can systematically integrate, recombine, and adjust innovative elements and thus contains substantial potential for new-quality transformation.

1.1.2 Pattern and Structure

Spatial pattern and spatial structure are the “two engines” of urban design. Structure is the basic skeleton or network through which physical spatial elements form a whole, and it expresses the fundamental diachronic and synchronic configuration of urban form [3]. The two are interdependent but distinct, although they are often conflated in practice.

A pattern is configured according to the internal organization and developmental logic of a spatial type. It is a generalized abstraction of essential characteristics, and both its content and its expression remain abstract; the same pattern may generate many variants. A structure, by contrast, emerges within a specific site and environment. Although it may be represented by abstract symbols, its content is concrete, and every spatial structure is therefore particular.

Pattern exists within structure as background knowledge or a precondition. It is a deeper mechanism that is both more self-evident and less visible than structure. In expressions such as “centralized” or “distributed” structure, for example, the suffix denotes a pattern rather than a form. Beijing’s spatial structure of “one core, one primary center, one subcenter, two axes, multiple nodes, and one ecological conservation area” is likewise founded on a concentric-ring pattern. Structure may thus be understood as the concretization of pattern, yielding the approximate relation: typological pattern + environmental variables → specific structure.

1.1.3 Review of Existing Research

From this perspective, research and practice explicitly devoted to spatial patterns remain scarce. Existing studies generally focus on the organization and layout of a single spatial type. They cover innovation spaces such as makerspaces, science-and-technology new towns, local innovation networks, and third places; industrial spaces such as e-commerce parks, airport economies, digital economies, and small-scale manufacturing; transport spaces such as international hub ports, airport clusters, multiscale rail-station integration, and smart TOD; residential spaces such as fifteen-minute living circles, perimeter-block neighborhoods, neighborhood centers, and elder-care communities; and cultural and sports spaces, among others [4-16].

Building on summaries of current practice, these studies propose type-specific improvements or innovations through individual cases. Yet systematic discussion of spatial patterns themselves and of the principles governing their innovation is rare. This gap first requires clarification of the multidimensional factors and relational mechanisms that shape spatial patterns. Four groups of factors are especially important.

1.2 Factors in the Formation of Spatial Patterns

1.2.1 Functional Type

Spatial patterns address the general laws of organization, operation, and development associated with particular spatial types. They must therefore be differentiated according to the internal requirements and basic logic of each type. Industrial spaces and transport hubs offer two illustrative examples.

Industrial space may be subdivided by sector and level into specialized parks. A new-energy vehicle manufacturing park, for instance, must organize its productive factors around a complete chain of “core manufacturing - component manufacturing - parts supply - pilot research and development - automotive aftermarket development.” The corresponding elements include leading large enterprises, medium-sized producers of intelligent core components, small and medium-sized parts manufacturers, research-oriented start-ups, pilot-testing facilities, closed test platforms for intelligent connected vehicles, and automotive exhibition areas. These must be rationally configured in scale, layout, and process from upstream material preparation and component production, through midstream vehicle assembly, to downstream automotive services, so as to maximize output at minimum cost. The production model determines the spatial pattern.

TOD areas, by contrast, commonly adopt a concentric-ring pattern. Boundaries, radii, and the number of rings around a station are established according to walking distance, land-use function, graded development intensity, and land value [17]. This makes it possible to optimize functional composition, development intensity, and cluster form at different locations and to apply gradient controls. Such regularities are not immutable; they evolve progressively with technological change.

1.2.2 Development Trends

The future trajectory of a spatial type is critical to the foresight, scientific validity, and innovativeness of its pattern, and is therefore central to pattern innovation. University space and infrastructure space illustrate this point.

The most significant recent trend in universities is a shift from disciplinary separation under the traditional collegiate system toward innovation-oriented interdisciplinarity - a paradigm change in knowledge production from division to integration. Educational concepts, methods, and tools are undergoing unprecedented transformation. Supported by information technology, new models have emerged, including online open courses, knowledge platforms, proto-entrepreneurship, integrated living and learning, interdisciplinary collaboration, and self-customized education [18].

Innovation in teaching models drives the reconstruction of campus patterns. The conventional arrangement of separate departmental buildings is becoming more open, spontaneous, and integrated. Universities increasingly establish wider social exchange and collaboration with cities and communities, emphasize the connective capacity and interaction density of public space, and create universal or indeterminate spaces that blur disciplinary boundaries. New campus types, including “special zones for interdisciplinary development,” have also appeared [19-20].

Infrastructure, meanwhile, exhibits a pronounced trend toward compound integration and integrated innovation. This includes high-level integration among transport, municipal, safety, energy, and logistics systems, as well as the combined provision of infrastructure and public-space resources, including public facilities, parks, green space, and underground space [21]. Infrastructure is thereby released from its conventional subordinate and passive role. Its diverse cultural values [22] and social effects are rediscovered, enabling it to become a leading agent of urban spatial development and a new frontier for urban design.

1.2.3 Society and Culture

Social and cultural influences on spatial patterns encompass value orientations, social networks, local knowledge, lifestyles, and architectural types. The simultaneous forces of globalization and locality draw cities into the cultural production and social governance of “modernity.” Urban design continually seeks spatial patterns that balance global consumerism with place-based humanistic settings.

Cultural space and green open space provide useful examples. Modern museums, galleries, and libraries have moved beyond elite collecting institutions to address the general public. In essence, they are media through which cultural symbols circulate between East and West, across social strata, and between physical and virtual realms. While producing national, ethnic, or community identity, they also reproduce social relations through mass cultural consumption. They therefore possess powerful capacities for aggregating people and industries and for catalyzing change. Combined with what Hans-Georg Gadamer described as the “festive” and the “everyday” [23], cultural facilities have differentiated into two fundamental patterns: strong centralization and micro-centralization.

One is the familiar clustered cultural district, in which multiple institutions coexist as autonomous entities, host and originate major urban events, and attract upstream and downstream services. The other is distributed and community-based: cultural energy is dispersed into a wider range of grassroots spaces, stimulating renewal and development in surrounding areas. Sendai Mediatheque, Seattle Central Library, and Helsinki’s Oodi Library, for example, greatly expanded community-service functions and floor area, becoming cultural and everyday-life complexes freely accessible to all age groups. Connected to one another, such facilities generate network effects.

Green open spaces similarly reproduce these centralized and distributed logics in void rather than solid. As important generators of urban culture and metropolitan society, they create differentiated environments for social innovation through public education and social interaction: New York’s Central Park represents the centralized form, while pocket parks such as Paley Park exemplify the distributed form.

1.2.4 Development Model

The development model and its economic feasibility are also decisive in determining whether a spatial pattern can be realized. Manhattan’s homogeneous subdivision of land produced equivalent juxtaposition and a “rainforest” cityscape. Likewise, standardized products of the modern city - CBDs, airports, shopping centers, universities, industrial parks, theme parks, and art museums - have directly generated convergent spatial patterns and urban operating systems.

Residential space and community services again illustrate the issue. Contemporary large-scale commodity-housing estates, uniformly developed, sold, and leased by real-estate companies, differ fundamentally from traditional detached housing or self-built development on small parcels. They mass-produce a homogeneous residential landscape across cities. More recent policies encouraging contiguous land development have, however, created opportunities for integrated pattern innovation.

Community-service space is becoming increasingly compound and intensive. The “9+X stacked” model of the Home Center in Beijing’s Municipal Administrative Center emphasizes the vertical mixing of multiple community services and three-dimensional spatial governance. In Shanghai, professionally facilitated community gardens enable residents to redevelop underused green spaces within housing estates, introducing a self-organized pattern that empowers ordinary individuals to participate in city-making.

2 Pattern Innovation

2.1 The Core of Innovation in Urban Design

The essence of spatial-pattern innovation is organizational innovation: “new combinations of old elements.” This is also Joseph Alois Schumpeter’s classic definition of innovation [24] - the recombination of existing factors of production. Projected into spatial planning, it corresponds to the innovative allocation of production factors that characterizes new-quality productive forces.

In other words, spatial-pattern innovation creatively recombines conventional spatial elements. These new combinations can stimulate new behaviors, generate new drivers, industries, and services, and provide additional application scenarios for new-quality productive forces [1]. By engaging with the spatial mechanisms through which relations of production and social relations are formed, and with their connective and configurational logics, spatial patterns can creatively reorganize technology, capital,

institutions, and labor. Space thereby becomes an important enabling condition and practical instrument for new-quality economic and social development.

This perspective moves beyond the aesthetic emphasis on morphology that has long dominated urban design and marks a methodological transition from shaping spatial form to configuring spatial patterns. Pattern innovation, rather than formal novelty, is therefore the substantive core of innovation in urban design, whether the aim is to improve an existing model by reducing costs and increasing efficiency or to create a new model capable of deeper transformation. The question is how elements should be recombined to produce new-quality space. The answer lies in the underlying logic of the elements available for combination and of the relationships through which they are organized.

2.2 Underlying Logic of Pattern Innovation

2.2.1 Attributes of Elements

The objects of combination are not the physical forms of spatial elements as such, but the basic attributes of material space. These attributes can be organized into four binary pairs corresponding to form, environment, function, and time: void and solid, public and private, generic and specialized, and fixed and variable.

“Void and solid” refer to the two primary formal categories of urban open space and built space. “Public and private” describe degrees of openness and privacy; the extent of access and sharing indicates the intensity of energy and information exchange with the external environment. “Generic and specialized” refer to the universality or specificity of spatial functions. Specialized space is relatively autonomous because it is closely tied to the scale, context, technologies, and facilities required by a particular function. This pair may also be extended to genericity and heterogeneity, which together produce spatial ambiguity and diversity. “Fixed and variable” introduce time: the certainty of spatial rules and the uncertainty of content, expressing the dialectical unity of constancy and change in pattern configuration. The four pairs are both independent and interrelated and constitute the material basis through which all spatial elements can be combined and transformed.

2.2.2 Organization of Relationships

The combinatorial relationships among spatial elements can be broadly summarized through two paradigms: centralization and decentralization. These describe how elements agglomerate and circulate and how their organization evolves. They are realized through two basic modes of organization: external organization and self-organization. Hermann Haken, the founder of synergetics, defined a system as externally organized when imposed external intervention controls the emergence of spatial, temporal, or functional structure; the reverse condition is self-organization [25]. Self-organization is the mechanism through which a system develops wholeness and new qualities, and it is widely regarded as an internal law of urban spatial development [26].

In concise terms, spatial patterns emerge when the attributes of elements enter centralized or decentralized relationships through external organization or self-organization. Four fundamental configurations follow: centralized external organization, decentralized external organization, centralized self-organization, and decentralized self-organization.

Centralized external organization is the most conventional planning approach. Across times and regions, it commonly takes the form of top-down vertical hierarchy and centralized control, resembling a machine. Although efficient in construction and operation, it often produces homogeneity, monotony, and fragmentation.

Decentralized external organization reflects a flattening tendency from overall structure to units and individuals. It includes transitional conditions such as polycentricity and micro-centralization. By deliberately removing vertical hierarchy and limiting imposed intervention, it seeks to strengthen organizational vitality and innovation.

Centralized self-organization usually presupposes some form of material or immaterial external organization. The material form coordinates and provides high-quality spatial resources - central districts, parks, metro stations, education and health facilities - drawing population and resources inward. The immaterial form uses rules, including public policy, technical protocols, and civic agreements, to guide self-financed construction, self-building, and self-governance, producing spontaneous order. Such systems appear autonomous and egalitarian, yet larger-scale centers may remain indirectly shaped by the state or capital.

Decentralized self-organization depends more deeply on the coordination of institutions and technologies. It involves fundamental questions of land transfer and use, spatial governance and the redistribution of power, and differentiation within social structures. At the same time, evolving distributed technologies empower individual freedom while combining with underlying protocols, algorithms, and infrastructure to form the invisible hardware and software of the city's "operating system."

2.3 A Combinatorial Matrix of Spatial Patterns

Arranging the eight attributes of elements against the four forms of relational organization produces a combinatorial matrix of spatial patterns (Table 1 and Figure 1). The matrix includes historical classics such as the Garden City, New York's Central Park, the work-unit compound, detached housing, and Barcelona's open blocks; standardized contemporary models such as cultural centers, gated communities, station-city integration, and pocket parks; and future-oriented or experimental propositions, including flexible production, the supersurface, community self-building, and the avant-garde works of Archizoom, Superstudio, and OMA.

The matrix provides a foundational atlas for pattern innovation, enabling patterns to be crossed and recombined. At the Liangzhu Campus of the China Academy of Art, for example, architectural elements that combine publicness and genericity were reorganized through decentralized self-organization to create the "Continuous Workshop." Its prototype can be traced to the 1960s project No-stop City.

The thirty-two diagrams in the original atlas take three forms. The first are abstract patterns expressing general principles. The second are representative cases: the Kanazawa Museum can be understood as an architectural prototype of distributed space, while MIT's Infinite Corridor, Chuangzhi Community Garden, 798 Art District, and Tianjin Cultural Center represent distinct pattern categories. The third are framework diagrams positioned between abstraction and concreteness; by isolating a single decisive element, they make the essence of a pattern immediately legible. All are foundational, inventive, or forward-looking concepts and models.

Table 1. Spatial Pattern Matrix

Element attributes	Centralized external organization	Decentralized external organization	Centralized self-organization	Decentralized self-organization
Open space	01 Central Park model: a centralized open space aggregates people, information, technology, and capital and supports the formation of diverse urban centers.	02 Barcelona open-block model: an evenly distributed street network and public interfaces organize urban functions and weaken centripetal hierarchy.	03 Shanghai community-garden self-building model: catalytic interventions activate local self-organizing capacity and produce heterogeneous micro-centers.	04 Pocket park / POPS model: public policy and institutional design stimulate bottom-up, distributed production of public space.
Built space	05 Garden City model: multiple urban centers of different levels and types are established and connected; the dominant model is composed of building clusters.	06 Linear City model: single-center ring expansion is replaced by infrastructure corridors that connect multiple externally organized centers.	07 Catalyst model: physical attractors guide the spontaneous movement and agglomeration of resources, producing diverse fields of activity.	08 Oosterwold “Free Haven” housing model: an experimental form of self-organization that enables individuals to participate directly in building the modern city.
Publicness	09 Cultural and sports center model: capital replicates standardized modern spatial products, including transport hubs, theme parks, and CBDs; the pattern tends to be singular.	10 Infrastructure-ring model of Beijing’s Municipal Administrative Center: external organization integrates and allocates high-quality spatial resources to produce a polycentric configuration.	11 Boundary pattern: a polarized boundary triggers self-organized flows and centralizes them, as in Koolhaas’s conceptual experiments.	12 Patchwork pattern: self-organized and distributed, with equivalent juxtaposition, wandering routes, nonlinear associations, and spatial polysemy that generate network effects.
Privacy	13 Ancient-capital construction system: multiple city walls, palace walls, and ward walls were arranged around imperial authority, creating a privatized centralized pattern.	14 Compound model: blocks composed of enclosed compounds form a matrix of “small worlds” that must be transformed toward openness and mixed use.	15 Polarization pattern: spontaneous clustering around high-quality spatial resources, exemplified by housing-price distribution, reflects the self-organizing operation of the market.	16 Blockchain pattern: decentralization at the level of the individual; distributed technologies enable a fluid structure of “large-scale dispersion and small-scale concentration.”

Element attributes	Centralized external organization	Decentralized external organization	Centralized self-organization	Decentralized self-organization
Genericity	17 Flexible production model: production factors and innovation resources are integrated and recombined to transform established industrial-space patterns toward new quality.	18 Stripe pattern: a unity of genericity and difference with many variants; heterogeneous elements and specialized functions can be inserted between the stripes.	19 MIT Infinite Corridor model: a public communication space connects building groups and allows interdisciplinary interaction to generate an innovation center spontaneously.	20 No-stop City model: a generic spatial prototype that provides architectural infrastructure for self-organized activities and decentralized relationships.
Specialization / heterogeneity	21 TOD model: multiple specialized spatial types centered on transport hubs; functions are arranged in concentric rings and have become a regularized pattern.	22 Stripe pattern: each band contains different content but is juxtaposed on equal terms; decentralized logic is integrated through weak one-directional control.	23 798 model: an urban heterogeneous patch possesses the spontaneous energy to incubate a center and converts its distinctiveness into a dedicated theme.	24 Detached self-built housing model: self-organization and heterogeneity are delegated to the smallest unit; diversity and density in a distributed configuration are central.
Certainty	25 Concentric-ring pattern: ring roads establish highly certain infrastructure and urban form, reinforcing the central position and relationships of external organization.	26 Framework pattern: the Korean capital-relocation proposal releases the open possibilities of enclosed space. As a grid variant, it exposes a decentralized structure.	27 Escher figure-ground pattern: void and solid can exchange value equivalently in a self-organized morphological transformation, suggesting the existence and direction of a center.	28 Field pattern: metastable random distribution under an invisible force field; ambiguous and multivalent spatial relations stimulate self-organized behavior.
Uncertainty	29 Boundary pattern: a determinate boundary activates indeterminate content without disorder, as in the Urban Halo proposal for Shenzhen Crystal Island.	30 Matrix pattern: a grid variant in which nodes act as catalysts for uncertain events, scenarios, and relationships while preserving network effects.	31 Archipelago pattern: accommodates, absorbs, or facilitates the spontaneous formation, connection, movement, and transformation of numerous micro-centers.	32 Patchwork pattern: decentralized space empowers spontaneous connections and combinations among individuals, increasing the possibility and freedom of interactive innovation.

On this basis, the paper further distills eight pattern prototypes and their corresponding schemas, each containing known or as-yet-unexplored potential for innovation. More essential and abstract than type-specific models, they can be translated across spatial categories. Flexible production, for example, is an innovative model for manufacturing space and belongs to the concentric-ring prototype. The following sections use design practices and cases to explain systematically the principles and application scenarios of the eight prototypes.



Figure 1. Eight Prototypical Schemas of Spatial Patterns

3 Eight Innovative Pattern Prototypes

3.1 Stripe

The stripe is a decentralized pattern produced through external organization. It derives from the theoretical model that Rem Koolhaas developed in *Delirious New York* [27] from the stacked section of the skyscraper and its “shelf” principle to represent metropolitan consumer culture. Koolhaas then applied it creatively in the competition for Parc de la Villette in Paris, a project widely regarded as a point of departure for landscape urbanism.

The parallel arrangement of stripes dissolves predetermined centers of value and hierarchy and produces a decentralized relationship of equivalent juxtaposition. In essence, one-directional control by an external organization is used to maximize the scope for self-organization between the bands. Heterogeneous architectural and landscape elements can be inserted freely, providing a formally simple regulatory framework for mixing, hybridizing, and recombining the contents of mass culture. The openness and inclusiveness generated by such weak control mobilize the autonomy, randomness, and simultaneity of connections among individuals - the smallest units of innovation - and reshape urban culture through the exchange of value.

The author applied this prototype to the design of the South Central Axis Cultural District in Beijing, including a museum cluster and supporting service areas. Running east-west, the stripes connect ritual, represented by the Central Axis, with music and recreation, represented by Nanyuan Park. The public spaces of the museums are extracted and arranged in parallel to form an integrated framework of elongated buildings. The buildings and the “spaces” between them accommodate, respectively, homogeneous and heterogeneous, fixed and variable, public and private, and generic and specialized attributes. The aim is to “make the public even more public,” enabling cultural space to perform its proper functions of public education and social innovation.

The stripe breaks with the conventional model of separate, self-contained cultural institutions. It reconstructs the cultural district as a cultural park in which architecture, landscape, and urban space are designed as an integrated whole, thereby completing a place-specific translation of the prototype (Figure 2).

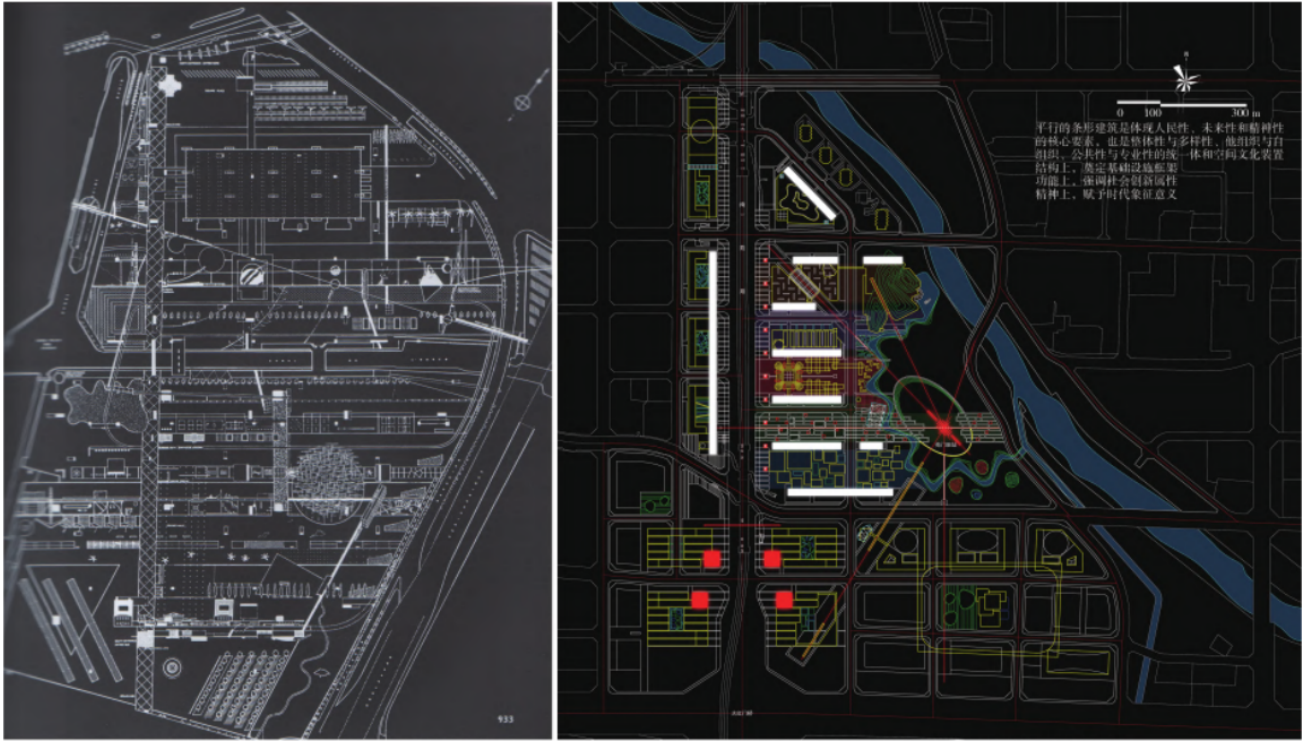


Figure 2. Design Translation of the Stripe Pattern

Source note: Figure 2(a) is adapted from the Chinese edition of EL CROQUIS, No. 9, Rem Koolhaas: Works 1987-1998.

3.2 Concentric Ring

The concentric ring is the most common centralized pattern. It can powerfully aggregate factors of production and innovation resources, increase the density of exchange, improve connectivity and service quality within innovation environments, and thereby strengthen new-quality productive forces.

The flexible-production model^① used in the Weibei Industrial Park in Xi'an provides an example. Through externally organized instruments such as planning techniques and policy, the model integrates and couples the small and medium-sized enterprises within a manufacturing chain. Such firms typically provide upstream and downstream production support and industrial services to leading or large enterprises. Their strong dependence causes them to follow the location and layout decisions of major firms, while traditional specialized parks remain fragmented, internally dispersed, and poorly equipped to generate the integrated and collaborative innovation needed for industrial upgrading.

The new pattern concentrates these enterprises spatially and uses land more intensively. While reducing costs and simplifying management, it creates flexible, immediate opportunities for interaction, recombination, and innovation among similar and related firms. Over time, it can build local industrial-service clusters, shared innovation platforms, and enterprise ecosystems, attracting additional large firms through high-quality, large-scale supporting services.

This “new combination of old elements” reverses the subordinate relationship between service-providing and service-receiving spaces. It reserves spatial conditions for chain-based growth and iterative innovation in advanced manufacturing and ultimately translates the new industrial-space pattern into an overall structure of production-city clusters connected by a ring (Figure 3).

The concentric-ring pattern can likewise be applied to innovation spaces such as science-and-technology new towns and innovation districts. In such contexts, certain functional spaces are organized around the uncertainty of innovation activities. Third places for informal exchange and open blocks centered on everyday life can thus be used to reform the capital-driven building-economy model.

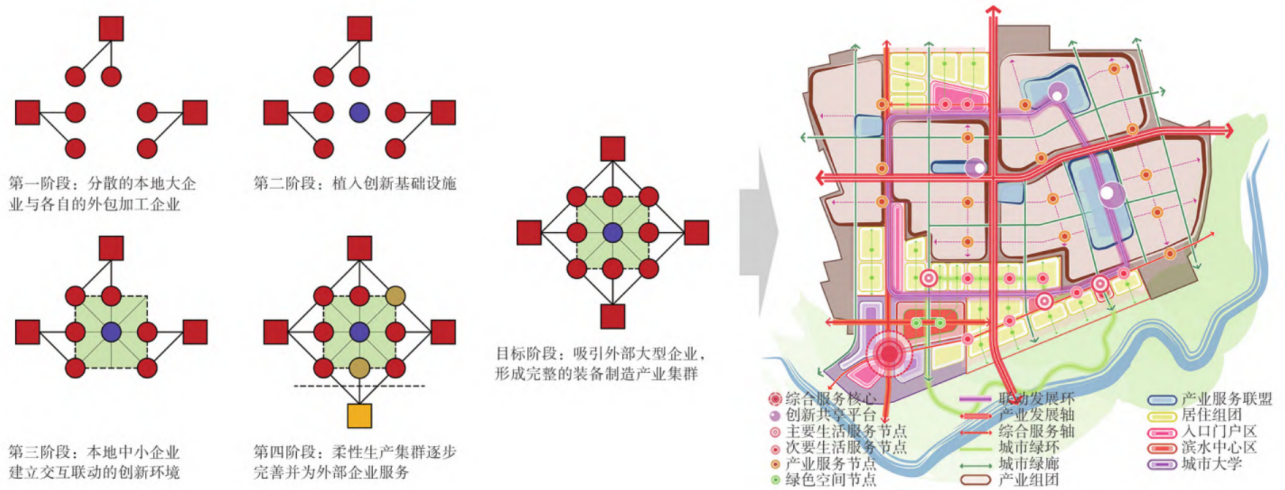


Figure 3. Transformation of the Flexible-Production Model into an Industrial Spatial Structure

3.3 Grid

The grid is not only a universal and efficient urban form, design method, and analytical tool; it is also an a priori open system and one of the most inclusive, complex, and flexible underlying patterns. Kevin Kelly [28] called it an “icon of the twenty-first century.” A grid may be externally organized or self-organized, centralized or decentralized.

On the one hand, its neutrality, homogeneity, standardization and reproducibility, and holistic structure allow it to absorb difference into itself without privileging any individual object. The simplicity and stability of its form paradoxically release richness and uncertainty in its content. This extraordinary capacity for inclusion was first pushed to an extreme in Ludwig Hilberseimer’s 1922 proposal for the Chicago Tribune Tower competition. The grid was subsequently used repeatedly by avant-garde groups as a symbol of “modernity,” extending across experimental architecture and urban design.

On the other hand, the cellular and topological properties of the grid provide virtually unlimited possibilities for flexible transformation. These are evident in the divisible and recombinable organization of Manhattan’s merged blocks and Barcelona’s superblocks [29-30]. The grid can also reverse void and solid, for example by transforming infrastructure corridors into built form.

In DOGMA’s competition proposal for relocating the capital of South Korea to Seoul, transport and municipal infrastructure were placed underground. Above ground, cruciform residential “walls” replaced the orthogonal street grid as the sole architectural motif. Relying only on the elementary relationship of enclosure, the walls established the city’s framework and image while bringing the enclosed “spaces,” with all their difference, richness, and uncertainty, to the foreground. The walls themselves receded into an infrastructuralized three-dimensional background. Although highly speculative, the proposal vividly demonstrated the grid’s intrinsic capacity to balance figure and ground and to generate solid and void from one another.

3.4 Patchwork

Patchwork refers to the bottom-up, non-hierarchical horizontal juxtaposition - or vertical stacking - mixing, and dissolution of numerous heterogeneous elements, functions, or spatial modules. Like a woven carpet, it appears as a distributed assemblage and is a typical decentralized, self-organized pattern.

Its elements are connected by ambiguous, polysemous, and nonlinear relationships. Users may choose their own routes, define space, and establish immediate connections, allowing diverse activities, events, and scenarios to be woven densely together and activating the complexity and experiential intensity proper to an urban system. By treating the inclusion and connection of heterogeneity as both a social process and a

technical means of producing creativity, the pattern supports formal and informal spaces of exchange and innovation-oriented public environments.

In the design of the Wuyuan Bay Complete Community in Xiamen and the central district of Taihu Science and Technology New City in Wuxi, the prototype was developed through three-dimensional zoning in both horizontal and vertical directions. The horizontal layer is public and constitutes a mixed generic space; the vertical layers contain housing or offices and are specialized private spaces. The design focuses on a carpet-like near-ground urban fabric and uses modular composition to stack and interlock many forms of third space at high density, upgrading public space into an open field of innovation (Figure 4).

The two projects differ in their fifth façades. According to their functional type and regional context, one becomes a continuous roof garden and the other an undulating Jiangnan-style pitched roof. Each entire district is thus covered by a unifying ecological or cultural sign, demonstrating the fundamental and adaptive character of the patchwork pattern.



Figure 4. Modular Spatial Configuration of the Patchwork Pattern

3.5 Archipelago

The archipelago is a governance metaphor for future urban and rural spatial patterns. It consists of an “ocean” and “islands.” The ocean is constructed through tangible and intangible policy and technical rules, platform algorithms, infrastructure, and underlying protocols. It overlays the land and the visible city with an expanding layer of invisible regulation, like an electronic skin. It may be understood as the matrix landscape of abstract global space or digital-media society, defining the overall condition of human digital existence.

This digitally constructed artificial ground has the characteristics of a space of flows: openness, contingency, ambiguity, and extensibility. It enables smooth transitions among what it covers and weakens the independence of individual entities. The islands, by contrast, are shifting polycenters or micro-centers. They correspond to the heterogeneous components of spatial configuration and embody forces that resist social separation, systemic control, and digital colonization through diverse critical interventions, including Wang Shu’s architecture, the revival of folk crafts in Bishan, and social design [31].

Within the ocean created by capital, numerous individual narratives appear to enjoy unprecedented freedom of expression but are in fact controlled and pulled by a larger decentralized force. They display synchronic continuity and diachronic difference. Capital encourages, encloses, and ultimately absorbs difference - as when rock music, contemporary art, or regional culture is incorporated into its own matrix - and the greater the difference, the more spectacular it becomes.

The center disappears visually, and variation at the scale of the individual cannot alter the whole. Formal operations at the scale of the single object therefore lose strategic significance: proportion, rhythm, detail, and other aesthetic devices give way to the indeterminacy, processual character, and self-organization of the

landscape matrix. Exceptional landmarks and monuments are no longer emphasized; instead, they dissolve into an “environment without architecture” [32].

Superstudio's Supersurface and Archizoom's No-stop City can be regarded as modern prototypes of the archipelago pattern^②. They anticipated an ultimate nomadic condition of humanity. The author translated their mechanism into a concept for consumer space in Chengdu Panda “Metaverse Valley.” A “super-flat interface” embedded in the shallow-hill terrain gives architecture and landscape a unified matrix condition with its own generative capacity and metropolitan effects.

Physical space becomes a medium between real and virtual worlds, while people, objects, and events are treated as heterogeneous scenes that provide backgrounds or scripts for socializing, entertainment, and shopping. Mediation dissolves the representational meaning and aesthetic rules of architectural form. Its in-between, temporary, and anti-formal character fundamentally overturns conventional spatial experience. Every material surface can produce, share, and transmit information, creating a language that is lightweight, image-based, and dynamic (Figure 5).

Here, use value gradually gives way to exchange value. Through the virtual-real superimposition, real-time switching, and scalable expansion of information and situation, experience and imagination, global and local, and offline and online, media simultaneously construct and refresh space while reproducing meaning. They become a re-structuring force of social design.



(a) Superstudio的实验作品“超级表面”组图

(b) 成都熊猫“元宇宙谷”概念设计的空间介面图景

Figure 5. Modern Prototypes and Design Translation of the Archipelago Pattern

Source note: Figure 5(a) is adapted from Gabriele Mastrigli, Superstudio 1966-1978: A Legendary Architectural Group without Architecture, Chinese trans. Ni Anyu, Xu Mingsong, Chen Zhixiu, et al. (Chongqing: Southwest China Normal University Press, 2018). Figure 5(b) is from the conceptual design for “Metaverse Valley,” the southern commercial district of the Chengdu Research Base of Giant Panda Breeding, by Beijing Tsinghua Tongheng Urban Planning and Design Institute Co., Ltd.; the design drawing was prepared by the author.

3.6 Linear Form

The linear form derives from the early modernist model of the “Linear City.” Spatial resources are arranged in a line and connected by a transport axis, producing an externally organized, polycentric pattern. In a broader sense, the linear form includes axial-development models and can generate banded, fishbone, and ring-shaped structural variants. It is therefore widely applicable.

The most extreme current example is Saudi Arabia's The Line, now under construction: a straight city linking mountains and sea, 170 km long, only 200 m wide, and 500 m high, with an underground ultra-high-speed transport system powered by artificial intelligence and renewable energy at its core. The project is intended to accommodate nine million people.

Behind its surreal formal simplicity lies a political logic of “de-tribalization,” or decentralization. At the historical moment when the Saudi royal succession system is shifting from succession among brothers to succession from father to son^③, Crown Prince Mohammed bin Salman must weaken the earlier tribal

alliance to legitimize and stabilize a new political order. Relying on highly materialized infrastructural technologies, The Line becomes a core instrument for transforming a tribal social structure into an atomized one and for completing a new national narrative and mode of governance. Because the linear pattern makes tribal organization spatially difficult and favors atomization, spatial production externally reorganizes social production.

3.7 Boundary

As a spatial pattern, the boundary can be understood through Martin Heidegger's definition of space: "Something that has been made room for is admitted within a boundary. A boundary is not that at which something stops but, as the Greeks recognized, that from which something begins its presencing" [33]. In other words, a boundary is the beginning of space and concerns its essence. The process of bounding can intensify the qualities of the space within.

In the Urban Halo proposal for the Shenzhen Crystal Island competition, for example, a monumental circular ring - an elevated pedestrian passage - defined the boundary of the central district while maximizing freedom and diversity inside it: anything could occur within the ring without producing disorder. Similarly, Sou Fujimoto's proposal for the Environmental Art Forum in Annaka and the pocket park at Yongjia Road in Shanghai use enclosed or open boundaries to form spaces capable of spontaneous emergence, adaptation, and self-definition, generating ambiguous, multivalent, and richly changing public fields. The pattern exerts its flexible framing and field effects primarily at meso- and micro-scales.

The conceptual design for the permanent venue of the Zhongguancun Forum confronted a highly complex site. The project lies in the core of the Three Hills and Five Gardens historic landscape, where buildings are limited to 9 m, the visual character is highly sensitive, functions are diverse, and land is constrained. The site therefore had to collect, respond to, and transform numerous environmental factors and internal-external relationships.

The proposal reduced this complexity to a clear framework. By materializing the regulatory "boundary," it created a style-neutral elevated platform, 9 m above ground and extending across the site to maximize the replication of public benefit. The platform offers an open and inclusive urban public space for exchange and innovation (Figure 6).

Above it lies a public-art plaza that integrates cultural context with technological themes and visually coordinates the surrounding historic urban landscape. Below it are conference and performance venues, product launches, cultural exchange, and other functions. The platform also unifies the architectural character in three dimensions. Patchwork can be used beneath it to dissolve distinct spatial modules, mixing and hybridizing them into an indeterminate building cluster capable of fostering innovation. The platform itself becomes a horizontal landmark and catalyst.

The platform is both a material boundary for overall control and the interface between urban design and architectural design. The landscape above and the buildings below may be entrusted to specialist teams, while the primary task of urban design is to resolve the boundary. Without redundant formal representation, the proposal integrates urban design, architecture, landscape, and art.



Figure 6. Proposed Elevated Public Exchange Platform for the Zhongguancun Forum

3.8 Unit

The unit is a basic component of urban space and a common pattern that integrates external organization with self-organization. Work-unit compounds, gated communities, and open blocks all shape the extensive realm of “ordinary” urban space. Innovation in the unit pattern is therefore highly consequential and operates at two levels.

The first is the opening and mixing of the unit itself. Units should permit varying degrees of exchange of information and energy with the external environment, especially through the public transformation of local streets, urban interfaces, and rooftop spaces. Private space can be shifted inward to access-control points or elevator lobbies. While promoting spatial justice and regulating capital, this creates a continuous, boundary-free public-space base and increases opportunities and efficiency for open innovation.

The second is the accommodation, mixing, and intensification of functionally differentiated activities at the finest possible grain, including mixed allocation at the parcel and building scales. In community units, creative industries can be embedded to return creativity to everyday life and produce innovation districts that integrate work and living.

The former Qing Army and Navy Ministry compound in Beijing, the open residential quarters on Paris’s Left Bank, Beijing’s Contemporary MOMA, and Tianmuli in Hangzhou are all “small-world” units rich in diversity and vitality. The self-sufficiency and exchange value generated by mixing naturally promote decentralization of the overall urban pattern and have far-reaching consequences for spatial development.

4 Conclusion

The alliance and continuous iteration of capital and technology are profoundly reshaping planning and design, a field whose core is spatial production. Innovation in spatial patterns is required to align new-quality productive forces with new relations of production and to provide the spatial conditions and foundational platforms from which a culture of innovation can emerge.

The eight prototypical schemas proposed in this paper constitute a preliminary theoretical framework for pattern innovation. Subsequent research can expand and refine it. Its significance for urban-design practice can be summarized at three levels.

Conceptual level. Compared with the mechanistic and aesthetic thinking prevalent in mainstream practice, pattern-based spatial cognition and design open a more inclusive and generative model of thought grounded in organizational innovation. Mechanism design centered on rules and processes can replace blueprint planning, while the logic of pattern construction can replace formal compositional rules. By empowering and

releasing the heterogeneity, mixture, and complex relations of grassroots actors and individuals, this approach can help shift practice from external organization toward a paradigm that combines external organization and self-organization.

Application level. Each prototype contains multiple dialectical relations: form and content, rigidity and flexibility, simplicity and complexity, concealment and appearance, singularity and diversity, totality and individuality, and genericity and difference. These relations enable patterns to integrate and coordinate diverse material and immaterial carriers in a clear and concise manner, give form to specific sites and environments, remain readily operational, and adapt flexibly to temporal and spatial differences.

Innovation level. The foundational character of patterns, especially prototypical schemas, can support and stimulate innovation at multiple levels. First, new patterns can emerge through the invention and derivation of prototypes and through cross-combination among patterns. They can shift and translate between spatial types and scales, producing multiple variants and enabling innovation in either a whole system or a local part.

Second, new structures can be built on new patterns. These go beyond conventional structures that lack explicit consideration of pattern and are therefore more critical, forward-looking, and practical. They improve the capacity of spatial production to supply richer future scenarios of social organization, perception, and use with greater precision, thereby shaping diverse forms of new-quality space.

Third, patterns can generate a new language of urban design. The established design language based on figure-ground relationships and geometric elements is strongly intentional, hierarchical, and solid. A pattern-based language necessarily exceeds the limitations of sharply bounded figure and ground; it becomes ambiguous, dynamic, and even fluid, and may develop in two directions: naturalization and algorithmization.

The naturalized direction uses prototypes such as grids, stripes, lines, and rings to build open infrastructural frameworks. Immaterial mechanisms and rules then guide self-organized construction within them, generating a rich, living language that designers cannot prescribe in advance. This language grows from the bottom up and is juxtaposed with, and complements, the minimal language of the foundational framework.

The algorithmic direction uses technology and computation to give a particular pattern an integrated language of city, architecture, landscape, and infrastructure: a topological geometry fundamentally different from conventional figure-ground representation and a digitally produced artificial ground. The rise and spread of digital objects will further strengthen the materiality and reality of algorithmic, or immaterial, spatial production. The design innovations opened by pattern research deserve sustained investigation.

Notes

① The “flexible production” model was introduced in China by Professor WANG Jici of Peking University. It refers to a highly flexible post-Fordist mode of production characterized by differentiation, process innovation, combined automation, and networked organization, including subcontracting and enterprise alliances. It readily supports innovative clusters and local production systems formed through cooperation among small and medium-sized enterprises within an industrial chain or across similar chains.

② Superstudio’s collage experiments - including *Twelve Ideal Cities*, *Continuous Monument*, and *Fundamental Acts: Life, Education, Ceremony, Love, and Death* - used the grid as an artificial surface symbolizing modernity. Expanding into an all-encompassing “supersurface,” they anticipated a nomadic human future. Similarly, Archizoom’s *No-stop City* used fully distributed infrastructure and a regular interface matrix to expose the contradiction of an existence that appears free but is in fact tightly regulated.

③ Saudi Arabia is an Arab alliance state composed of multiple tribes and families and historically followed a system of succession among brothers. After the present monarch’s son, Mohammed bin Salman, became crown prince, a series of political and economic initiatives - strengthening the cultural brand of historic Diriyah, constructing The Line, and transferring the national entertainment sector to the Wahhabi family responsible for religious affairs in order to weaken its sacred authority - reinforced a new national narrative, shifted succession toward father-to-son inheritance, and consolidated the new political order.

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