A Conceptual Model of the Architectural Design Process Focusing on Geometric Knowledge within Design Thinking

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Abstract

Background and Objectives: Geometry in architectural design has often been approached primarily as a formal and technical instrument for generating spatial configurations. However, its deeper cognitive, epistemological, and conceptual dimensions within the architectural design process have received comparatively limited attention. This study aims to investigate the role of geometric khnowledge in architectural design thinking and to formulate a conceptual framework that explains how this generative system contributes to the understanding, organisation, transformation, and realisation of architectural ideas. The research seeks to clarify spatial logic not merely as a representational tool, but as a foundational language embedded in the logic of design phases.

Materials and Methods: This research adopted a qualitative methodology based on the Grounded Theory Method (GTM). Data were collected through semi-

Keywords:
Architectural Design, Geometric Knowledge, Grounded Theory, Conceptual Model, Design Thinking.

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Research Questions:

1. How does the architectural design process operate with a focus on geometric knowledge within design thinking?

2. What is the role of geometry in guiding design decisions throughout this process?

structured interviews with 20 prominent architects and university professors specialising in architecture and design studies. The collected data were analysed using ATLAS.ti software through three stages of coding: open coding, axial coding, and selective coding. This analytical process enabled the identification of key concepts, categories, and interrelationships, ultimately leading to the development of a conceptual model explaining the function of these structural principles in architectural design processes.

Results and Conclusion: The findings demonstrate that spatial configuration beyond its conventional role as a form-generating tool and functions as a language for perception, cognition, organisation, and realisation in architecture. The study identified several influential dimensions shaping the role of geometry, including cultural-historical, philosophical-epistemological, aesthetic, educational-professional, and environmental factors. Based on the analysis, a five-stage geometric model was developed, consisting of geometric cognition, geometric perception, geometric organisation, geometric transformation, and geometric realisation. This model conceptualises architectural design as an iterative and evolutionary process through this spatial logic evolves from mental abstraction into spatial manifestation.

The proposed framework positions it as a structural foundation integrating conceptual, functional, and spatial aspects of design. Furthermore, the model synthesises major architectural design theories—including design thinking, Lawson's three-stage model, and Alexander's pattern-based approach—within a coherent geometric logic. The study contributes a novel theoretical perspective on architectural design as a process of geometric transformation and provides a practical framework applicable to architectural education, geometry-based digital design tools, and contemporary architectural practice.

1. Introduction

The architectural design process comprises a complex set of mental, cognitive, cultural and technical interactions.

1. A. Khiabanyan, *Creativity in the Architectural Design Process* (Tabriz: Mehr-e Iman Publications, 2009), 50; H. Beyti et al., 'The Participatory Role of Users in the Design Process of Residential Spaces,' *Spatial Planning*, no. 1 (June 2023): 117–138; S. Rezaei Ashtiani, 'Explaining the Research-Oriented Design Process Model in Architectural Design Studios' (Shahid Rajaee University, Tehran, 2020), 20; G. Rahimi, 'The Concept of Body in Avicennian Physics,' *Journal of Avicennian Wisdom*, no. 44 (Autumn & Winter 2010): 176; M. Hadian and H. Pourmand, 'Design Concept in Architecture: A Necessity in the Design Process and the Challenges of Its Education in Schools of Architecture,' *Biannual Journal of Applied Arts*, no. 4 (September 2014): 75; A. NooriMokaram et al., 'Investigating the Components of Concept Formation in Architectural Design Education with a Background-Oriented Approach,' *Bagh-e Nazar*, no. 120 (June 2023): 31; N. Cross, *Designerly Ways of Knowing* (London: Springer-Verlag, 2007); D. Schön, *The Reflective Practitioner: How Professionals*

It begins when an architect decides to create a work and continues until the design is ready for implementation. This process constitutes the core essence of architectural practice and distinguishes the nature of architecture from other fields of art and engineering. Numerous scholars have defined this path as the design process and have identified specific stages for it, including problem identification, idea formation, evaluation, and the realisation of the design,[1] Since the nature of architecture is fundamentally intertwined with design, architectural theories are also directly or indirectly engaged with design knowledge and its processes. However, due to the distinctive nature of architecture and its particular modes of thinking and expression, theories of architectural design have continually been subjects of discussion and reconsideration.[2] In recent decades, alongside social, economic, and philosophical transformations, design theories have increasingly focused on the cognitive dimensions of design, including perception, mental activities, and the designer's way of thinking[3].

Among these discussions, one of the areas that has received less systematic attention in relation to the process is the position of geometric knowledge.[4] Although geometry has always been present in architecture as a tool for drawing, spatial organisation, and form generation, in many prevailing models of the design process its role has largely been limited to the level of a tool or a language of form, while its cognitive dimensions have been less thoroughly explained[5]. This condition, both in theoretical models and in architectural education systems, has led to geometric thinking being given less conscious attention as one of the fundamental bases of design thinking[6]. Conversely, research in design cognition indicates that the use of various modes of thinking, including visual, analogical, and geometric thinking, can contribute to improving the quality of the design process.[7] Moreover, technological developments in recent decades, along with the emergence of digital, algorithmic, and parametric tools, have transformed the role and nature of geometry in architectural design. Nevertheless, many design process models still fail to provide a clear framework for analysing these transformations and explaining the role of complex and computational geometry in design thinking. In response to this theoretical gap, this article examines how geometric knowledge operates within architectural design thinking, proposing a conceptual framework to clarify its role throughout the design process.

Research Questions:

This study seeks to answer the following questions:

1. How does the architectural design process operate with a focus on geometric knowledge within design thinking?
2. What is the role of geometry in guiding design decisions throughout this process?

2. Research Objectives

The article aims to formulate a conceptual framework for comprehending the architectural design process, paying particular attention to the evolutionary role of geometric knowledge across the successive stages of design thinking.

3. Research Methodology

This qualitative study employs a systematic

Think in Action (New York: Basic Books, 1983); B. Lawson, *How Designers Think: The Design Process Demystified*, 4th ed. (Oxford: Architectural Press, 2005).

2. H. Rezaei et al., 'A Psychological Meta-analysis of the Relationship Between Form and Function in the Architectural Design Process from the Perspective of Creativity,' *Innovation and Creativity in Human Sciences*, no. 2 (Autumn 2018): 266.

3. K. Mardomi and M. Dehghani Tafti, 'Presenting an Applied Model of the Architectural Design Process Based on Islamic Ontology,' *Islamic Architecture Research*, no. 16 (Autumn 2017): 105, A. Mahmoudi, 'Thinking in Design: Introducing the Interactive Thinking Model in Design Education,' *Fine Arts Journal*, no. 20 (January 2005) , J. Anderson, *Cognitive Psychology and Its Implications* (New York: Macmillan, 1995).

4. R. Oxman, 'Theory and Design in the First Digital Age,' *Design Studies*, 3 (2006): 229–265.

5. H. Pottmann et al., *Architectural Geometry* (Bentley Institute Press, 2007).

Grounded Theory Method (GTM), predicated on the Strauss and Corbin model, to formulate a conceptual framework for architectural design. Data were garnered via semi-structured interviews with 20 to 30 purposively selected experts, complemented by an extensive review of scholarly literature, continuing until theoretical saturation was unequivocally achieved.

Concurrently with data collection and upon attaining theoretical saturation, the data were subjected to a tripartite coding process: open, axial, and selective coding. This analytical procedure was executed utilising ATLAS.ti software to guarantee both the precision and comprehensiveness of the analysis. Following the development of the conceptual (paradigmatic) model, its validity was rigorously evaluated through qualitative methods—encompassing theoretical saturation, expert review and corroboration,[8] and comparative analysis with extant literature—to ascertain the model's robustness and reliability Figure 2.

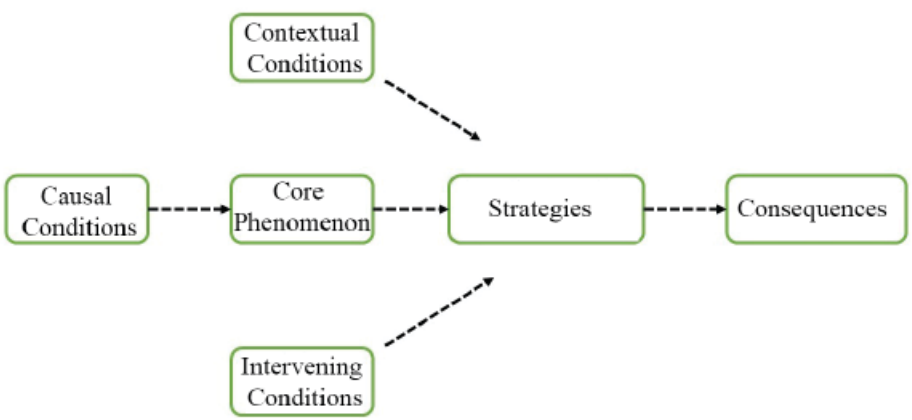
To guarantee reliability and validity, this research employed participant validation, peer review, and expert evaluation. Credibility was established through iterative cross-checking and constant comparative analysis, thereby ensuring intersubjective consistency across all categories. Furthermore, findings derived from observations and document analyses were triangulated with participant feedback to corroborate content validity.[9]

Consequently, the study rigorously implemented all validation protocols, including interviewee verification of categories, expert appraisal of conceptual credibility, iterative data cycling, and constant comparison. These measures collectively facilitated theoretical saturation and model integration, thereby substantiating the model's overall validity and reliability.

6. A. M. Salama and N. Wilkinson, *Design Studio Pedagogy: Horizons for the Future* (The Urban International Press, 2007).

7. G. Goldschmidt, 'The Dialectics of Sketching,' *Creativity Research Journal*, 2 (1991): 123–143.

Figure 1. Strauss and Corbin Model. Source: Maqsood Fereydoun Farasatkhah, *Qualitative Research Methods in Social Sciences with Emphasis on Grounded Theory* (Tehran: Farhangban Publications, 2019), 101.



4. Literature Review

Since the mid-twentieth century, the process has emerged as a pivotal theoretical discourse. Herbert Simon's seminal work, *The Sciences of the Artificial*, initially defined design as a decision-making and problem-solving activity, bridging extant and desired states via analytical reasoning; this inherently established the rational, linear model of design.[10] In direct response to this rationalist view, critics such as Christopher Alexander, in *Notes on the Synthesis of Form*, challenged these rationalist paradigms by accentuating the complex, interdependent nature of design variables. He posited that design amalgamates analysis and synthesis, guided by an apprehension of underlying structures rather than pure logic, thereby demonstrating how geometric and structural order bridge form and function.[11] In the 1980s, Donald Schön's theory of reflective practice conceptualised design as 'thinking-in-action', emphasising the designer's intuition, experiential knowledge, and reflec-

tion in ideation, alongside the critical role of the creative cognitive process.[12] From the 1990s onwards, design cognition theories like Dorst and Cross's Function–Behaviour–Structure (FBS) framework conceptualised design as a complex system of interactions. This model, evolving through designer-mental model feedback, was an early framework to explain design logic through complex systems rather than purely intuitive descriptions.[13]

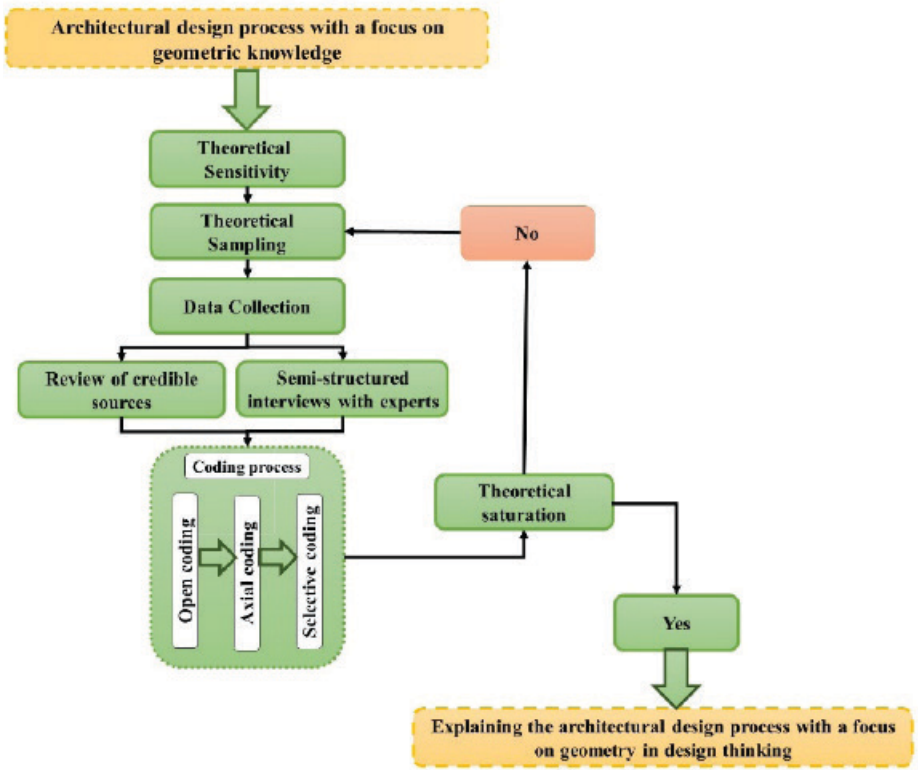
Furthermore,the co-evolutionary model postulates design as the concurrent evolution of problem and solution, where the designer actively redefines the problem throughout the process. This perspective illuminates the dynamics of design in complex contexts.[14] In a parallel development focused on process stages, the UK Design Council's Double Diamond model delineates a four-stage process: Discover, Define, Develop, and Deliver. By emphasising iterative and cyclical oscillations between divergent and convergent thinking, it establishes the foundation for numerous contemporary design methodologies.[15]

A distinct but related shift concerns geometry's role. Generative geometry, coalescing with the advent of digital technologies, conceptualises geometry not merely as a representational tool but as an active medium for generative, creative cognition. This approach enables the creation of complex structures and new design possibilities[16]. Nevertheless, despite geometry's historical presence in architecture, much of the design literature has treated it reductively, primarily as a tool for formal expression rather than a more integral element of the design process. Turning to regional contexts, studies concerning Iranian architecture reveal geometry's dualistic role, signifying both aesthetic harmony and cosmic/ontological unity within traditional paradigms. Although recent scholarship explores the integration of these principles via digital methodologies, a systematic, geometry-centric framework for the design workflow remains conspicuously absent.

As a result of these gaps,existing literature, by focusing narrowly on either the formal/geometric aspects of form or cognitive design processes, has under-examined geometry's structural role. This research gap prompts the question: How can geometry serve as a framework for thinking, organising, and realising design? To address this question directly,this

8. Strauss and Corbin Model, Source: Maqsood Fereydoun Farasatkhah, *Qualitative Research Methods in Social Sciences with Emphasis on Grounded Theory* (Tehran: Farhangban Publications, 2019), 101.

Figure 2. Research Process Diagram, Source:authors.



study employs grounded theory to investigate this creative sequence through the lens of geometry's role.

5. Theoretical Framework

5.1. Models of the Architectural Design Process

This process is inherently complex, seamlessly blending analytical reasoning with creative intuition. Historically, various models have been formulated by theorists and practitioners to encapsulate the diverse facets of this multidimensional activity.[17] Design models function as conceptual frameworks that organise design stages, decision-making protocols, ideation, and evaluation. Their structural typologies vary contingent upon project scope, designer objectives, user engagement, and intrinsic complexity. Models founded upon the analysis–synthesis–evaluation triad, originating from rationalist paradigms, remain foundational within architectural planning literature.[18] Conversely, methodologies such as design thinking and concept testing prioritise creative, open-ended, iterative, and user-centric processes.[19] These iterative frameworks are particularly efficacious for complex projects with heterogeneous requirements, facilitating continuous conceptual refinement. In parallel, systems-based and Building Information Modelling (BIM) approaches mitigate the technical and data-driven complexities of contemporary design, emphasising interdisciplinary coordination across sectors such as energy, building services, construction, and lifecycle maintenance.[20]

Participatory and human-centred models, exemplarily embodied in Christopher Alexander's *A Pattern Language*, foster unmediated interaction between architects and users. They conceptualise design as a collaborative synthesis of dialogue, spatial experience, and the comprehension of human environments. Systematically categorising these models empowers architects to select the optimal methodological approach and rigorously guide the design trajectory.[21] Consequently, to analyse and formulate the final model, extant architectural design paradigms were classified into five primary categories predicated on their methodological approaches Table 1. This taxonomy facilitates pattern identification, perspective differentiation, and the recognition of critical gaps regarding geometric application.

Architectural design process models vary in their approach to complexity. Linear and cyclical models focus on stage sequence or iteration, respectively. Concept-test and problem-solving models emphasise continuous evaluation. Functional, systems-based, and analysis-synthesis-evaluation models offer a structural, logic-based view, while creative, participatory, and analogical models highlight intuitive, collective, and adaptive aspects of design.

Various architectural design process models presented in the literature have each sought to explain the complexity and multidimensional nature of this process and to analyse it from different perspectives. Linear and cyclical models emphasise either the sequence of stages or the iterative nature of the design process, respectively, whereas concept–test and problem-solving models focus on the continuous evaluation of concepts and solutions. Furthermore, functional, systems-based, and analysis–synthesis–evaluation models adopt a structural and logic-based perspective on the design process, while

9. M. Farasatkhah, *Qualitative Research Methods in Social Sciences with Emphasis on Grounded Theory* (Tehran: Farhangban Publications, 2019), 158.

10. H. Simon, *The Sciences of the Artificial* (Cambridge, MA: MIT Press, 1969)

11. Ch. Alexander, *Notes on the Synthesis of Form*. (Cambridge, MA: Harvard University Press, 1964).

12. D. Schön, *The Reflective Practitioner: How Professionals Think in Action*, (New York: Basic Books, 1983).

13. J.S. Gero and U.Kannengiesser, 'The Situated Function–Behaviour–Structure Framework', *Design Studies* 25 (2004): 373–391.

14. K.Dorst, and Nigel Cross, 'Creativity in the Design Process: Co-evolution of Problem–Solution', *Design Studies* 5 (2001): 425–437.

15. Design Council, *The Double Diamond: A Universally Accepted Model of the Design Process*, (London: Design Council, 2005)

creative, participatory, and analogical models emphasise the intuitive, collective, and adaptive dimensions of design.

A notable limitation of contemporary architectural design models is their disproportionate focus on the sequential 'how' and the procedural 'stages' of design activity, often obfuscating the specific epistemological bodies of knowledge employed. Consequently, the operational role of geometric knowledge remains largely implicit, rarely articulated as a discrete cognitive or structural mechanism. Therefore, the present study does not seek to critique or invalidate these existing models; rather, it aims to reinterpret and re-evaluate their latent capacity for elucidating the role of geometric knowledge within design thinking. In this vein, the research investigates how the cognitive and organisational dimensions of geometry facilitate process analysis, shape ideation, configure spatial layouts, and establish profound dialectics between form, function, and meaning.

5.2. Conceptualisation of Geometry in This Study

In this research, geometric knowledge is understood as a body of knowledge concerned with the quantitative and qualitative relationships of form, space, and order, through which the structure, proportions, organising patterns, and spatial logic of architecture can be analysed and designed. This knowledge can be examined from several perspectives. Proceeding to the first perspective, spatial ordering system may be understood as the science of measurement and proportion, employed in scaling and defining dimensional relationships, and manifested in both traditional and classical architecture through concepts such as the golden ratio and modular systems. Second, and complementarily, configurational logic functions as a language of order and structure, serving as an organising logic in plans, volumes, and façades, and establishing internal relationships among components within an integrated design system. Third, shifting from structure to process, formal language operates as a tool for design thinking, shaping ideas and translating concepts into form, thereby enabling a cognitive and conceptual understanding of the design process. Fourth, extending into the cultural realm, morphological framework can be regarded as a cultural and semantic language that, particularly in Islamic and Iranian architectural traditions, embodies meaning and symbolises unity, symmetry, and cosmic order. Synthesising these four perspectives, in this study, proportional system is not considered merely as a tool for measurement or formal ordering, but rather as a multidimensional design language and a framework for organising space, shaping form, and analysing the cultural and cognitive dimensions of the design process.

6. Discussion and Analysis

Employing a Grounded Theory Method (GTM), this study aimed to construct an independent conceptual framework derived empirically from field data. To ensure the acquisition of valid and comprehensive insights, semi-structured interviews were conducted with architectural academicians and practitioners. These dialogues captured expert perspectives and practical heuristics germane to the research inquiry. Complementary data were garnered via a systematic review of relevant archival documents

16. I.G. Dino, 'Creative Design Exploration by Parametric Generative Systems in Architecture',*ODTÜ MimarlıkFakültesi*, 1 (2012): 207-224; S, Nasiri, and Ali Reza Sarvdalir, 'Geometrical Origin of Generative Shape Grammars for Islamic Tectonics',*Nexus Network Journal*, 1 (2023): 177-195.

17. B. Lawson, *How Designers Think: The Design Process*,(Oxford: Architectural Press, 2006); N. Cross. *Research in Design Thinking*. (Delft: Delft University of Technology, 2006)

18. W. Peña, and S. Parshall, *Problem Seeking: An Architectural Programming Primer*,(New York: Wiley, 2001).

19. V. Kumar, *101 Design Methods: A Structured Approach for Driving Innovation in Your Organisation*, (Hoboken, NJ: Wiley, 2013); N. Cross,*Design Thinking: Understanding How Designers Think and Work*, (Oxford: Berg Publishers, 2011).

and specialised literature, substantially enriching the analytical depth. This methodological triangulation facilitated a multidimensional, evidence-based approach to qualitative data analysis, ultimately culminating in the extraction of a robust conceptual model. Following data saturation, qualitative analysis was executed employing the tripartite coding protocol (open, axial, and selective coding) intrinsic to systematic GTM. This analytical rigour was designed to transparently map the logical linkages between raw data, emergent concepts, and core categories, thereby ensuring the study's replicability.

Commencing with the open coding phase, raw textual data from transcripts and documents were disaggregated into discrete units of meaning. Initial codes were subsequently assigned to each segment predicated on its

Approach	Model	Description	Gap related to geometry
Classical–Structural and Iterative and evaluation-oriented	Linear Model	It views design as a continuous linear sequence of stages including analysis, concept generation, design, and implementation. This model is highly simple but offers limited flexibility.[22]	Geometry is implicitly present, primarily at the level of a tool for drawing and organising design outputs; its role as a cognitive mechanism within the design process is not explicitly articulated.
	Analysis-Synthesis-Evaluation	A logical and linear process consisting of initial data analysis, followed by synthesis to generate solutions, and finally evaluation of design outcomes. It has served as a foundational model for architectural design education in many schools of architecture.[23]	
	Cyclical or iterative model	Design proceeds through cycles of ideation, testing, feedback, and refinement. In this model, the designer can repeatedly return to earlier stages and make revisions. It is particularly suitable for complex and creative projects[24].	The focus is on feedback and the refinement of ideas; however, the role of geometry in shaping spatial logic and guiding design thinking is not systematically articulated.
	Concept-test Model	A process of evaluating and testing design ideas prior to full development. Each concept is assessed against criteria such as performance, aesthetics, sustainability, cost, and user satisfaction.[25]	
User-centred participatory	Design Thinking Model	Derived from innovative and user-centred approaches, it includes the stages of empathy, problem definition, ideation, prototyping, and testing. It is widely used in contemporary architecture and social design.[26]	The main focus is on user needs and participation; however, geometry has not been conceptualised as a structuring language of space or as a cognitive tool in the design process.
	Participatory Model	End users are actively involved in the design process. This approach is suitable for projects such as schools, residential housing, and urban spaces. It employs tools such as design workshops, interviews, voting, and collaborative model-making.[27]	

Table 1. Architectural Design Process Models, Source: authors.

20. D.W. Orr, *The Nature of Design: Ecology, Culture, and Human Intention*. (Oxford: Oxford University Press, 2002);American Institute of Architects (AIA),*The Framework for Design Excellence*. (Washington, DC: American Institute of Architects, 2022).

21. B. Lawson, *How Designers Think: The Design Process*,(Oxford: Architectural Press, 2006).

22. American Institute of Architects (AIA),*The Framework for Design Excellence*. (Washington, DC: American Institute of Architects, 2022).

23. Ibid

24. N. Cross,*Design Thinking: Understanding How Designers Think and Work*, (Oxford: Berg Publishers, 2011).

25. V. Kumar, *101 Design Methods: A Structured Approach for Driving Innovation in Your Organisation*, (Hoboken, NJ: Wiley, 2013); N. Cross, *Design Thinking: Understanding How Designers Think and Work*, (Oxford: Berg Publishers, 2011).

thematic substance, yielding an initial corpus of 420 preliminary codes were synthesised into cohesive conceptual clusters, each encapsulating a specific dimension of the geometry-design nexus. Proceeding to the axial coding stage,similar and related codes derived from open coding were grouped and organised into conceptual categories. This process involved identifying relationships among concepts, clustering codes based on semantic similarity, and determining core axes for each group. At this stage, the 420 initial codes were transformed into coherent conceptual clusters, each representing a specific dimension of the architectural

Approach	Model	Description	Gap related to geometry
Analytical and systems-based	Problem-Solving Model	It conceives architecture as a process of solving a specific problem. It emphasises the stages of problem definition, option generation, analysis, and selection of the best solution.[28]	Geometry is mainly addressed at the level of functional and spatial organisation; its role in conceptual decision-making and cognitive aspects of design is not explicitly articulated.
	Functional Model	It is based on the analysis of spatial functions and the relationships between them. The focus is on spatial performance, spatial relationships, circulation, and detailed functional programming.[29]	
	systems-based models	It views the project as a complex system composed of various components (users, environment, function, energy, climate, etc.). It emphasises the relationships between these components. It is suitable for large-scale and interdisciplinary projects.[30]	
Technological /digital	BIM-Based	It is based on Building Information Modelling (BIM). The design process takes place in a coordinated digital environment involving the architect, structural engineers, MEP engineers, and the client.[31]	Geometry is employed at a computational and operational level; its relationship with cognitive processes and design thinking has not been theoretically articulated.
	Generative Model	It involves the use of rules, algorithms, and data to generate adjustable and flexible forms. It is commonly applied in contemporary digital architecture (rule-based methods, evolutionary algorithms, and deep generative methods).[32]	
Intuitive/Creative	Intuitive/Creative Model	It emphasises intuition, creativity, and the designer's personal mindset. It is typically used in conceptual or artistic projects and employs tools such as freehand sketching, conceptual writing, and experimental models.[33]	The use of geometry is dependent on the designer's intuition and individual style; no systematic framework is provided for the guiding role of geometry in the design process.

Table 1 (continued). Architectural Design Process Models, Source: authors.

26. Ibid

27. Wacnik, P., Shanna R. D., & Aditi, V. 'Participatory design: a systematic review and insights for future practice.' Design Science 11 (2025): e21

28. N. Cross,*Design Thinking: Understanding How Designers Think and Work*, (Oxford: Berg Publishers, 2011).

29. W. Peña, and S. Parshall, *Problem Seeking: An Architectural Programming Primer*, (New York: Wiley, 2001).

30. D.W. Orr, *The Nature of Design: Ecology, Culture, and Human Intention*. (Oxford: Oxford University Press, 2002)

31. American Institute of Architects (AIA),*The Framework for Design Excellence*. (Washington, DC: American Institute of Architects, 2022).

32. Jiang, F., Ma, J., Webster, C. J., Chiaradia, A. J., Zhou, Y., Zhao, Z., & Zhang, X. 'Generative urban design: A systematic review on problem formulation, design generation, and decision-making.' *Progress in Planning* 180 (2024): 100795.

design process and its relationship with geometric framework.

In the selective coding phase, the objective was to distil the study's core category and articulate its relational dynamics with peripheral categories. The analysis revealed the central phenomenon to be: *Geometry as a cognitive pattern, an ontological axis, and a mediating construct in the manifestation of architectural concepts*. Peripheral categories were subsequently integrated into the theoretical framework based on their interactional influence on this central axis, thereby formalising the research's final paradigmatic model. Ultimately, the emergent categories were structured within a quintuple paradigmatic model Table 2: contextual conditions (7 categories), intervening conditions (6 categories), causal conditions (8 categories), strategies (5 categories), and consequences (6 categories).

In this study, based on a grounded theory approach, geometry is not conceived merely as a representational or computational tool, but rather as a cognitive, ontological, and meaning-generating pattern within the architectural design process. The findings indicate that geometry operates in the architect's mind as a language of thought and a structuring mechanism for concepts, establishing a connection between reason and imagination, intuition and

33. Lawson, Bryan. How Designers Think: The Design Process Demystified. 4th ed. London: Architectural Press, 2006

Table 2. An Overview of the Components of the Model Derived from Grounded Theory. Source: Authors.

No.	Conceptual Range	Categories	Conceptual Model
1	Connection with Tradition - Oral Transmission of Patterns and Archetypes - Conscious Geometry in Traditional Architecture - Hierarchy of Traditional Design - Organic Fabric of the City and Geometric Buildings	Cultural–historical contexts	contextual conditions
2	Creation through Synthesis - Hierarchy of Imagination to Visualisation - Forming of Imagination - Order of Creation - Gradual Growth of Knowledge - Geometry as the Understanding of Creation - Interconnection of Mind and Heart in Design	Philosophical–epistemological contexts	
3	Culture-dependent Beauty - Intrinsic Beauty - Evolutionary Beauty - Contextual Beauty - Symbolic Beauty - Secularisation of Beauty and Historical Shift in Perspective	Aesthetic contexts	
4	Critical Education - Gradual Teaching of Geometry - Formation of Design Personality - Skill in Sketching Ideas - Western-based Education - Superficial Understanding of the Past by Contemporary Architects - Traditional Theoretical Education	Educational–professional contexts	
5	Duality of Logic/Emotion - Designer/Engineer Approach (Solution-oriented/Problem-oriented) - Inspiration and Concept - Unity and Personalisation in the Design Process - Logical Rationalism and Historical Rationality	Design epistemology and process contexts	
6	Dominance of Form over Content - Fusion of Form and Content - Approach to Nature - Unity and Multiplicity of Form - Crisis of Modern Aesthetics - Contradiction between Function and Form - Reduction of Form Complexity	Intellectual–discourse contexts in architecture	
7	Climate and Environmental Harmony - Compatibility with Function and Human Needs - Sustainability and Resource Efficiency	Environmental and functional contexts	

representation, as well as logic and creativity.

The resulting theoretical model is structured around seven main components. Contextual conditions include cultural, historical, philo-

Table 2 (continued). An Overview of the Components of the Model Derived from Grounded Theory. Source: Authors.

No.	Conceptual Range	Categories	Conceptual Model
8	Mental Organisation through Geometry - Geometric Language - Skill-Based Foundation of Design - Visualised Design Thinking	Geometry as a thinking tool	causal conditions
9	Initial and Causal Presence - Step-by-Step Design Guidance - Performance and Environmental Evaluation Criteria - Geometry in Creative and Critical Aspects of the Design Process - Objectifying the Designer's Mental Schemas	Geometry as the core of the design process	
10	Simultaneous Performance and Meaning through Geometry - Relationship between Form and Essence Based on Geometry - Order and Flow of Space Based on Geometry	Geometry as a medium for meaning	
11	Harmony with Nature - Readability of Form and Space - Meaning Transfer and Feasibility of Execution	Human experience based on geometry	
12	Reflection of the Laws of Creation - Creation of Spatial Harmony and Balance - Translation of Dimensions and Scales into Geometric Structure	Geometric logic of the world	
13	Poetic Moment of Concept Creation - Creation of New Forms - Creative Composition	Inspirational aspects of geometry	
14	Structural Support - Stability of Forms - Coordination of Structure and Form	Geometry and structure	
15	Alignment with Function - Human Scale - Optimised Planning	Geometry and spatial function	
16	Poeticism and the Poetics of Architecture - Meaning and Beauty - Emotional Intelligence and Self-Awareness of the Designer	Values and poetics	intervening conditions
17	Experience and Skill in Geometry - Self-awareness and Other-awareness of the Designer - Cognitive/Perceptual Capacity of the Designer - Mastery of Techniques in the Realm of Form	Designer's perception and skills	
18	Simultaneous Rationality and Intuition - Imagination and Creativity - Production of New Combinations - Mental and Skill Limitations	Creativity and imagination process	
19	Geometry as a Tool, Not a Trap - Regularity and Geometric Character - Conscious Use of Numbers and Parameters - Avoiding Incorrect and Inauthentic Compositions	Use of geometry and tools	
20	Impact of Knowledge and Education - Experience and Imagination Alongside Drawing and modelling - Interaction with Works and Places - Adaptation to Contemporary Culture and Lifestyle	Interaction with culture, experience, and place	
21	Controlled Geometry - Mismatch Between Mentality and Reality (Idea and Form) - Excessive Transparency and Reduced Artistic Impact	Constraints and risks	
22	Geometry as a cognitive framework, vital core, and mediator of concepts in the architectural design process		Phenomenon

Table 2 (continued). An Overview of the Components of the Model Derived from Grounded Theory. Source: Authors.

sophical, aesthetic, educational, epistemological, intellectual, and environmental contexts that define the presence and role of geometry in design thinking and decision-making. Causal conditions consist of internal and cognitive drivers that lead to the centrality of geometry in design, including geometry as a tool of thinking, a core axis of the design process, a means of meaning expression, human experience, the logic of the world, inspiration, structure, and spatial functionality. In contrast, intervening conditions include values, skills, creativity, the

No.	Conceptual Range	Categories	Conceptual Model
23	Inspiration from Forms and Patterns - Mimesis and Poiesis - Deductive, Inductive, and Abductive Thinking - Importance of Framing and Defining the Design Problem	Inspiration and idea generation	strategies
24	Sketching Practice and Rapid Idea Visualisation - Two-Dimensional and Three-Dimensional Thinking - Ability to Transform Concept into Reality - Digital Design Tools and Advanced Geometry	Drawing and modelling skills	
25	Geometry as a Medium and Design Tool - Combining Shapes Based on Their Intrinsic Characteristics - Aligning Geometry with Function, Human Scale, and Context - Analysing Site Geometry and Layout	Geometry-based design thinking	
26	Control of Mind and Imagination (The Wild Horse of the Mind) - Decision-Making Based on the Geometric Identity of Shapes - Conscious and Justified Use of Geometry - Awareness of the Difference Between Design Process and Design Method	Design process control and decision-making	
27	Gradual Teaching and Master/Apprentice Relationship - Observation and Analysis of Works by Various Architects - Practice of Shape Combination and Transformation - Mastery of Rules and Creative Ability While Maintaining Geometric Consistency	Education and skill development	
28	Outstanding Artistic Work Emerging from Geometric Skill - Sustainable and Beautiful Composition - Durability of the Work and Continuous Discovery - Visual Appeal and Impact - Optimisation of Design Performance - Design Based on a Logical, Conscious, and Creative Process - Stronger Defense and Documentation of the Design	Design quality and durability	consequences[14]
29	Geometry as the Basis for Constructability - Stable Geometric Composition - The Relationship Between Geometry and Structural and Environmental Goals - Alignment of Digital Geometry with Tools and Advanced Construction Technologies	Structural strength, stability, and feasibility	
30	Geometry as the Language of Meaning - Symbolism and Secondary Meaning - Geometry-based Aesthetics - Reference to Hidden and Visible Layers	Integration of beauty and meaning	
31	Unity of Form and Meaning - Manifestation of the Inner in the Outer - Multilayered Expression in the Work - Geometry as the Mediator of the Material and Spiritual	Relationship between appearance and essence	
32	Coordination of Elements Based on Geometry - Legibility, Clarity, and Comprehensibility of Forms for the Audience - Overall Cohesion of the Design	Geometric unity and order	
33	Connection with Functional Musts and Must-Not's - Enhancing the Architect's Imagination - Strengthening Spatial Awareness and the Ability to Manipulate Forms Mentally - Creativity in Geometric Composition - Geometry as an Organising Tool and Design Guide - Creating Dynamic and Unique Forms and Spaces - Strengthening Analytical, Systematic, and Logical Thinking	Enhancing spatial thinking, perception, creativity, and organised innovation in design	

use of tools, cultural and spatial interaction, and constraints, all of which may strengthen or weaken this process. Accordingly, design strategies represent the conscious actions of the architect that shape the realisation of geometry in practice, ranging from inspiration and ideation to drawing, modelling, process control, and skill development.

The application of these strategies yields outcomes such as quality, durability, structural integrity, sustainability, aesthetic and semantic integration, geometric coherence, and enhanced structured creativity and innovation. Central to this theory is geometry, viewed as a cognitive and ontological pattern within the architectural design process, elevating design from a purely technical to a conceptual and ontological level. Accordingly, the model demonstrates that geometry in architectural design is not only a tool for organising form and space, but also a mental framework for thinking, meaning-making, decision-making, and creation. This model transforms design into a rational, creative, systematic, and meaningful process in which geometry plays a central role in shaping the architect's design thinking Figure 3.

The conceptual model derived from the findings of grounded theory revealed a paradigmatic framework of the core phenomenon of the study, namely geometry in the architectural de-

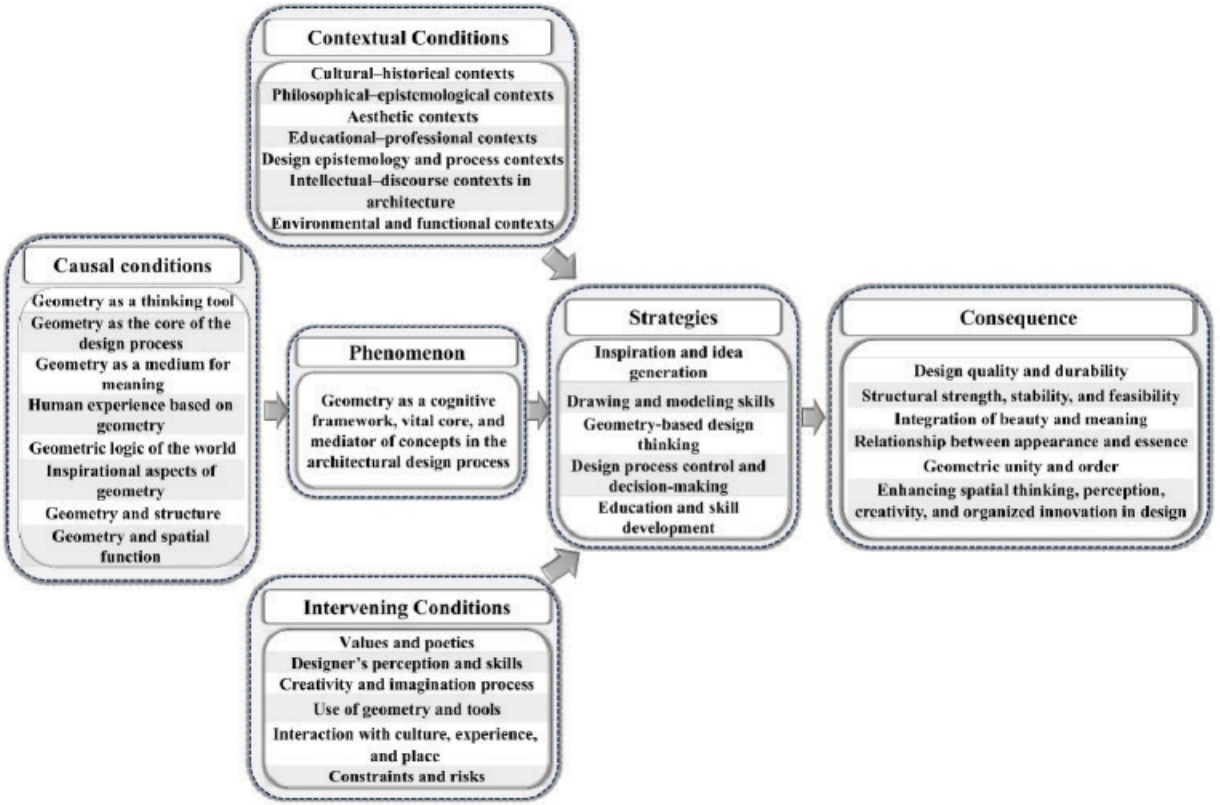


Figure 3. The conceptual model of geometry-centered architectural design based on the Strauss and Corbin paradigmatic framework. Source: Authors.

sign process. In this model, a set of contextual conditions, causal conditions, intervening factors, strategies, and consequences were identified, which, through their interaction, indicate that geometry is not merely a tool for form generation, but an epistemological and perceptual structure that is present throughout the entire design process and guides the designer's thinking. However, the paradigmatic model alone is not sufficient to explain the dynamics and continuous flow of geometric thinking within the design process.

Therefore, the dimensions of the grounded theory model were reorganised into a five-stage geometric model in order to clarify the process of formation and realisation of geometric thinking in architectural design. These stages include cognition, perception, organisation, transformation, and geometric realisation, reflecting the main dimensions of the paradigmatic model and illustrating the transition from theoretical understanding to design action. Accordingly, the design phases based on geometry is explained as a systematic and evolutionary movement from within to without; a movement that begins with cultural and cognitive foundations, continues through perceptual and mental organisation, is transformed into design action, and culminates in the material realisation of the architectural work. Within this evolutionary and recursive process, geometry acts as an intermediary language between the designer's mind and architectural reality, providing the foundation for the formation of meaning, structure, and creativity in design Table 3.

It is worth noting that in developing the

Five-Stage Geometry-Based Model	Corresponding Categories from the Grounded Theory Conceptual Model	Description
Geometric Cognition	Contextual Conditions	This stage focuses on the designer's intellectual and cultural foundations, where the understanding of the world and existence is shaped through geometry, and the theoretical principles of geometric design are established in the designer's mind.
Geometric Perception	Causal Conditions and Phenomenon	In this stage, geometry comes into play as a cognitive framework in the designer's mind, initiating the process of understanding, interpreting, and perceiving geometric structures in space and form.
Geometric Organisation	Intervening Conditions	In this stage, geometric perceptions are organised into a network of semantic and spatial relationships, allowing the designer to connect values, experiences, and skills.
Geometric Transformation	Strategies	At this step, geometric thinking is transformed into design action; ideas are materialised through geometry, and creativity takes shape within geometric order and logic.
Geometric Realisation	Consequences	The final outcome of the process is the emergence of the architectural work, where geometry unifies form and meaning, structure and concept, and mind and reality.

Table 3. A Five-Stage Conceptual Model, Source:authors.

proposed model of this study, three well-established design process frameworks—design thinking, Lawson's three-stage model, and Christopher Alexander's theoretical approach—were used as comparative theoretical foundations. It should be emphasised that these selected models are not considered complete frameworks in this research; rather, they are employed as interpretive structures with cognitive and structural capacity for re-examining the role of geometry in the process. Specifically,design thinking reflects a cognitive-exploratory and human-centred approach, Lawson's model highlights the analysis–synthesis–evaluation structure as the cognitive core of the design process, and Alexander's theory conceptualises design as an evolutionary process grounded in spatial patterns. The proposed model is positioned in continuity with these three theoretical perspectives and demonstrates that geometry-based design begins with contextual cognition, continues through the organisation of spatial relationships, and ultimately leads to transformation and material realisation. From this perspective,, the selection of these three models is intentional, situating the proposed model within three contemporary theoretical traditions: cognitive-analytical, human-centred, and pattern-based evolutionary design Figure 4.

7. Conclusion

Grounded in rigorous theoretical analysis and empirical expert interviews, this research sought to epistemologically reposition geometry within the design continuum – transitioning it from a mere formal and representational utility to the foundational cognitive structure of design thinking. In conventional paradigms, geometry appears only at certain stages, typically as a means of organising or representing form; however, the proposed five-stage model demonstrates that geometry can be situated at the very foundation of the design process rather than at its end. Accordingly, architectural design is understood as an experience of geometric thinking, in which the designer thinks, decides, and organises within a dynamic geometric framework from cognition to realisation.

Elaborating on these five stages, the proposed model, consisting of five stages – geometric cognition, perception, organisation, transformation, and realisation – depicts the design process as a continuous trajectory of geometric transformation. In the cognition stage, geometry is internalised as a cultural, historical, and theoretical foundation. In perception, it becomes a mental and spatial construct. In organisation, spatial relationships, rules, and hierarchies are defined. In transformation, these structures are translated into tangible and testable forms. Finally, in realisation, geometry is embodied in material, space, and lived experience. Thus, geometry is not merely a technical instrument but a cognitive and semantic system that integrates and guides the entire design process. What distinguishes this model from previous approaches is its conception of geometry as the structural foundation of architectural design thinking – an underlying system that integrates functional, conceptual, and spatial elements into a coherent framework. Within this perspective, architectural design emerges from the ongoing interaction between mind and world, geometric order and human intuition, analysis and creativity. Geometry functions not only as a tool for form-mak-

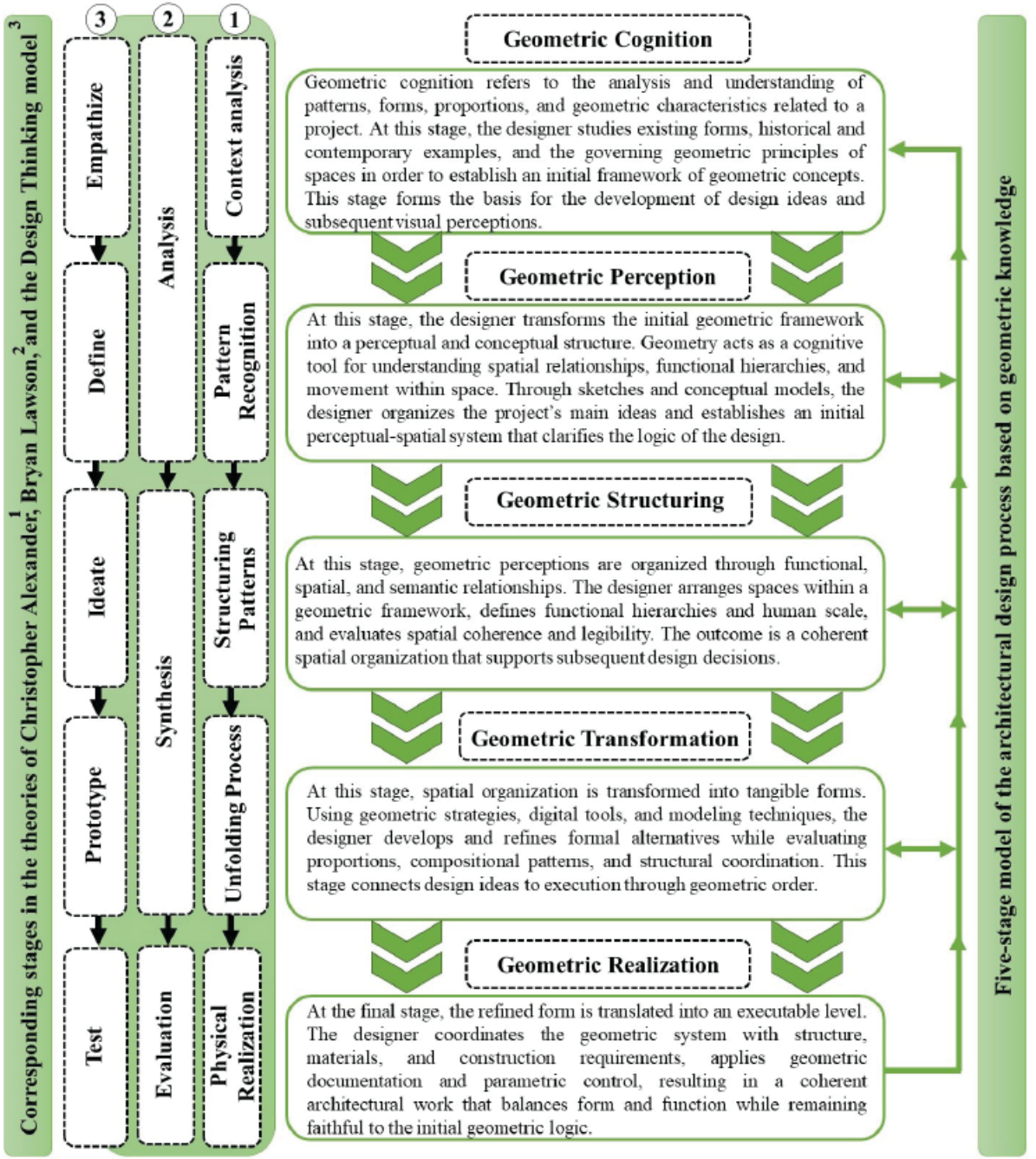


Figure 4. Five-Stage Model of the Architectural Design Process with a Focus on Geometry in Design Thinking, Source: authors.

ing but also as a framework for understanding, organising, and decision-making.

The model's connection to three established design frameworks – design thinking, Lawson's three-stage model, and Christopher Alexander's theory – demonstrates its theoretical depth and multidimensional grounding. Design thinking highlights the cognitive-exploratory and human-centred aspects of design; Lawson provides a structured analytical framework of analysis, synthesis, and evaluation; and Alexander reveals the evolutionary and pattern-based nature of form generation. The proposed model integrates these traditions within a coherent geometric logic, showing how geometry can act as a bridge between contextual understanding, spatial organisation, and material realisation. Ultimately, this five-stage model advances a paradigmatic shift, portraying design as an act of continuous morphogenesis that is simultaneously analytical and deeply creative, thereby equipping future scholarship and pedagogy with a profound mechanism for decoding the essence of spatial creation.

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