

Teaching Practice of Architectural Undergraduate Education Based on Geometric Graphic Training

Haojie Qian*

School of Architecture and Design, China University of Mining and Technology, Xuzhou 221116, Jiangsu, China

**Author to whom correspondence should be addressed.*

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Abstract: Against the backdrop of the deep integration of digital and AI technologies in architectural design, prominent drawbacks exist in traditional undergraduate architectural teaching. Solidified curriculum content and fragmented, overloaded teaching knowledge blur key teaching priorities, resulting in confused design thinking, deficient logical systems, and widespread neglect of basic architectural skills among students. Furthermore, the indiscriminate use of AI design tools has led to the degradation of students' active thinking and spatial construction literacy, leaving even senior undergraduates with insufficient practical design capabilities and fundamental logical flaws. To address the above teaching problems, this paper launches a specialized geometric graphics training course for senior architectural undergraduates. Returning to the essence of architectural design, it constructs a closed-loop design logic of "Demand—Elements + Techniques—Products—Demand". Through hierarchical and modular geometric training tasks, the course guides students to reconstruct design cognition, consolidate basic spatial construction capabilities, and establish systematic design thinking, while remedying competency degradation caused by over-reliance on AI tools. Teaching practice verifies that the progressive geometric training system can effectively standardize students' design logic and strengthen their spatial perception and construction ability, providing a replicable practical approach for the reform of basic architectural teaching and the improvement of students' core design literacy.

Keywords: Architectural undergraduate education; Geometric graphic training; Teaching practice; Design logic; Basic skill training

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1. Introduction

Fueled by digital transformation in the construction sector, AI image generation and intelligent modeling raise design efficiency and transform architectural undergraduate education^[1,2]. Current rigid curricula focus heavily on theories and cases, lacking systematic logic and basic skill training. Students acquire fragmented knowledge passively, leading to disjointed design thinking. They favor visual aesthetics over logical rigor and

constructability, neglecting core abilities for form and spatial creation.

Widespread AI application aggravates this problem. Many senior students rely excessively on AI to generate schemes and renderings, skipping form exploration and logical deduction. Their independent design capacity keeps declining. Despite completing coursework, most cannot build independent design logic or solve site-related problems, failing to meet professional standards without AI support.

Architectural design is rational spatial and formal construction, with geometric forms as the basis of architectural creation. Complex architectural configurations can be broken down into combinations and evolution of basic geometric units ^[3]. This reform therefore launches a geometric training course for senior undergraduates. Shifting from rigid lecturing to design fundamentals, it builds a closed-loop design logic system. Progressive practical tasks help students fix ability gaps, establish rational thinking, strengthen spatial construction skills, reduce AI dependence and improve independent design capacity.

2. Core problems in current undergraduate architectural education

2.1. Rigid teaching content and vague student cognition

Traditional teaching adopts fragmented, rigid knowledge frameworks. It prioritizes case analysis and formal innovation, while ignoring training on intrinsic design logic and foundational construction skills. Passive learning stops students from grasping architectural essence and forming complete thinking systems. Valuing visuals over reasoning, students tend toward blind imitation and random form stacking, producing shallow and repetitive designs.

2.2. Inadequate basic training and chaotic design logic

Senior courses concentrate on comprehensive innovative projects but overlook elementary form and spatial training. Insufficient early education makes students poor at geometric assembly, spatial shaping and scale control. When facing complex sites and functional demands, they cannot derive schemes from basic geometry. Without closed-loop thinking, their design process lacks solid evidence and clear optimization directions, making spatial layout and site adaptation insufficiently rational.

2.3. Over-reliance on AI and erosion of core literacy

While AI facilitates design work, it brings serious tool dependence. Many seniors directly adopt AI-generated outcomes, abandoning form exploration and scheme refinement merely to pursue visual effects. Misused AI gradually weakens students' spatial perception, geometric construction and logical reasoning. Unable to finish the full design workflow independently, students struggle to advance their comprehensive design literacy.

3. Core teaching philosophy and training logic of the course

3.1. Core teaching philosophy

Centered on the origin of architecture, this geometric figure training course adopts the core teaching philosophy of “returning to fundamentals, reconstructing design logic, consolidating professional literacy and breaking tool dependence”, and carries out targeted remedial and quality-improving training for senior students. Breaking the traditional “theory plus case” teaching mode, the course takes practical training as the priority, reduces tedious theoretical indoctrination, and strengthens the cultivation of underlying logic

and basic capabilities. It guides students to step away from over-reliance on AI tools and formalistic design misconceptions, and recognize their deficiencies in foundational knowledge and logical thinking. Starting from basic geometric figures, students rebuild the cognitive system of architectural form, space and site, and independently establish a scientific and complete logical framework for architectural design. This facilitates the transformation from “passive copying of drawings” to “active design”, and comprehensively improves students’ comprehensive capabilities in architectural design.

3.2. Closed-loop training logic for design

The course establishes an underlying closed-loop design logic of “Requirements → Elements + Methods → Outcomes → Requirements”, which runs through all training tasks and enables students to acquire transferable architectural design thinking (**Figure 1**). As the starting point of design, requirements cover multiple dimensions including site conditions, functional demands, environmental adaptation, humanistic spirit, economy and technology. Elements revolve around basic geometric figures, which serve as the fundamental carrier of architectural forms, spaces and components. Methods refer to design strategies for geometric figures such as combination, decomposition, repetition, deformation and interpenetration. Outcomes are the finalized architectural forms, spatial schemes and implementable deliverables. Ultimately, the outcomes are used to verify whether the initial design requirements are satisfied, forming a complete closed loop and eliminating groundless and illogical formalistic design.

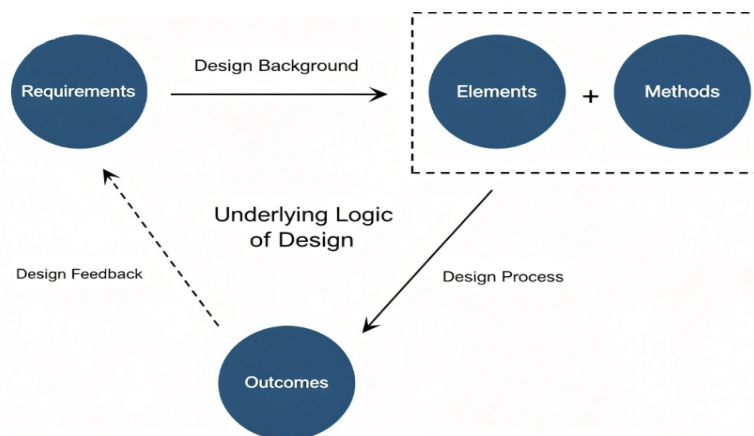


Figure 1. Underlying Logic of Design.

4. Design and practice of graduated training tasks for geometric figure training

This training course adopts a task-based teaching mode featuring hierarchical progression from shallow to deep. Six graduated training tasks are arranged covering basic cognition, theoretical sorting, case analysis, software operation and practical implementation on real sites (**Figure 2**). The tasks advance step by step to consolidate students’ capabilities in geometric construction and design logic, with balanced emphasis on basic training, thinking cultivation, practical implementation and problem-solving throughout the whole process.

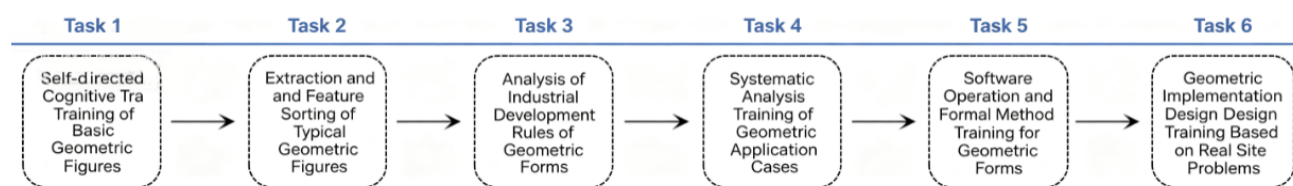


Figure 2. Training Process.

4.1. Task 1: Self-directed cognitive training of basic geometric figures

As an introductory cognitive task, this exercise arouses students' basic awareness, assesses their knowledge reserve and builds the consensus that "geometry forms the foundation of architecture". Students are required to hand-draw recognizable geometric shapes within 3 minutes without references or auxiliary tools. Unlike traditional cramming teaching, this student-oriented training directly reflects their command of basic design elements.

After the task, AI offers targeted feedback combining recognition and correction. It affirms students' cognitive strengths and identifies defects such as incomplete geometric recognition, ambiguous form classification and inadequate understanding of geometric application. Students will perceive their foundational gaps and grasp a core idea: architectural forms, components, spaces and site design can all be disassembled into basic geometry. Complex architectural design is the organized combination and rational deduction of elementary geometric elements, establishing a cognitive basis for further systematic training.

4.2. Task 2: Extraction and feature sorting of typical geometric figures

Based on basic cognition, targeted extraction training of typical geometric figures is conducted to transform students from passive acceptance to active research. Students select common geometric forms applied in architecture, urban planning and landscape architecture, and sort out their origins, morphological features, attributes and applicable scenarios (**Table 1**). Instead of fragmented learning, this task urges students to build a systematic cognitive framework and clarify the traits, spatial attributes and design value of various geometric figures.

This task aims to foster research-oriented design thinking, helping students trace the origin of architectural prototypes and refrain from arbitrary form generation and blind innovation. Students are expected to understand that architectural forms and spaces derive from prototypes rather than subjective speculation. The training eliminates formalistic and random design prejudices and cultivates rational design awareness based on sufficient evidence.

Table 1. Extraction and Feature Summary of Geometric Figures

Geometric Figure	Circle	Square	Triangle	Hexagon	Free Form
Diagram					
Characteristic	Centripetal Quality	Orderliness	Stability	Equilibrium	Freedom
Case Display					

4.3. Task 3: Analysis of industrial development rules of geometric figures

Focusing on disciplinary evolution, this task invites students to choose from urban planning, architectural design or landscape architecture. They systematically investigate the historical application of basic geometric figures, summarize their features, contextual variations and evolutionary rules across eras, and clarify the iterative logic of geometric elements in human settlement design (Figure 3).

This training cultivates students’ disciplinary awareness and systematic thinking, encouraging respect for design history, existing research and developmental laws. By combining historical context, students grasp the evolution of geometric forms: from simple mass stacking to refined combination, and from functional adaptation to integrated ecological and humanistic consideration. They learn to review history for present and future design, balance traditional principles with modern demands, and prevent blind innovation and broken logic in creation.

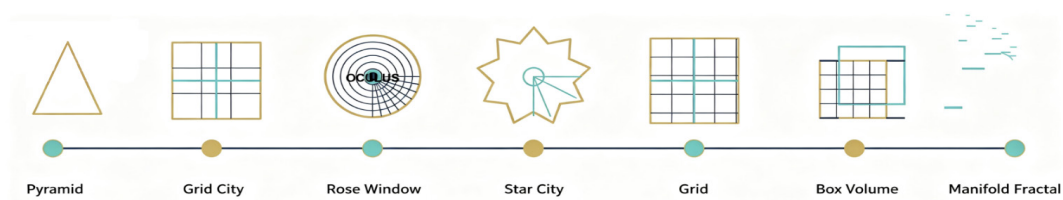


Figure 3. Development Context of Geometric Figures.

4.4. Task 4: Systematic analysis training of geometric application cases

Case analysis bridges theory and practice. Students are required to select at least five typical geometric spatial cases and carry out systematic analysis from four dimensions: prototype definition, application methods, design objectives and comprehensive evaluation (Table 2). Before training, instructors systematically illustrate criteria for element selection, involving function, site, climate, construction, spiritual expression, proportion, human scale and perception, offering a standardized logical framework for case study.

Prototype definition demands accurate extraction of core geometric prototypes and clarification of complex form composition. Application methods analyze geometric techniques including combination, division, repetition, deformation, interpenetration and subtraction. Design objectives focus on resolving site issues, satisfying functions and shaping space. Comprehensive evaluation covers environmental harmony, human adaptability, economy, technology and sustainability. This task develops students’ analytical skills and critical thinking, allowing them to interpret outstanding works, summarize design strategies, and accumulate theories and methods for independent design.

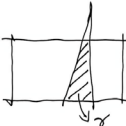
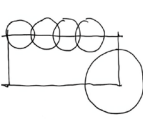
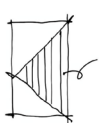
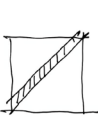
Table 2. Case Analysis of Geometric Figures

Case			
Diagram			
Summary	Combination	Proportion	Negative Form

4.5. Task 5: Software operation and technique training of geometric figures

Modeling software-based practical training grounded in real-site practice converts theoretical knowledge and case experience into practical competence. It comprises two progressive modules: basic form training and site characteristic training to strengthen students' geometric construction and technical application skills.

Table 3. Summary of Geometric Figure Design Techniques

	Student1	Student2	Student3	Student4	Student5
Diagram					
Technique 1	Rotation	Nesting	Superposition	Division	Nesting
Diagram					
Technique 2	Cutting	Interlocking	Cutting	Interpenetration	Division

Form Training I sets strict constraints: students may use only two geometric forms and one combination method to produce two distinct schemes. They need to justify technique selection and applicable scenarios for each work, ensuring rational form matching. This module aims to sharpen students' proficiency in single design techniques (Table 3).

Form Training II loosens combination limits. Students select multiple geometric forms of the same type and adopt one or more techniques to create two differentiated designs. It focuses on training iterative combination of homogeneous forms and flexible use of varied methods, enhancing the richness and logic of form design.

4.6. Task 6: Practical geometric design training based on real site problems

As the final comprehensive training, this site-based task assesses students' logical construction and practical design capabilities. Students choose a real site, define its dimensions, identify one or two core problems, analyze resulting site and functional drawbacks, and elaborate the logic of problem screening (Table 4).

Corresponding geometric design schemes are formulated according to site conditions. Following the logic of "Problem — Element — Technique — Solution", students specify intervention modes, geometric elements, design methods and their merits. They determine building scale, functional zoning and space layout, and generate interior and exterior renderings with AI to display geometric composition and spatial value. Simulating the full architectural design workflow, this task fosters students' problem-oriented, logically rigorous and implementable design thinking.

Table 4. Geometric Shape Design Training Based on Real Scenarios

	Student1	Student2	Student3	Student4	Student5
Site Selection					

Problem Identification	Lack of amenities around teaching buildings	Disordered forecourt of commercial plaza	Disordered forecourt of commercial plaza	Insufficient rest space for workers	Lack of transitional space at subway access
Design Strategy	Utilize corner space to enrich functions	Enhance entrance identifiability	Rezone and rationalize circulation	Provide rest services within green space	Break campus boundary for city-campus integration
Element Selection	Rectangle / Triangle	Rectangle	Rectangle	Triangle	Rectangle
Design Technique	Combination / Superposition	Interlocking	Void-solid integration	Elevation / Cutting	Setback
Effect Presentation					

5. Outcomes and reflections of teaching practice

5.1. Teaching practice outcomes

The graded geometric training resolves core challenges in senior architectural teaching and achieves satisfying results. First, students master the closed-loop design logic of “Demand—Elements & Techniques—Output—Demand”, avoiding chaotic thinking and arbitrary form creation, with greatly improved logic and constructability of designs. Second, students return to architectural essence and consolidate capabilities in form construction, spatial design and scale control. They reduce AI dependence and strengthen independent thinking and scheme optimization, making up for the deficiency of autonomous design ability.

The progressive training system ^[4] covers geometric cognition, case analysis, digital operation and site practice. Students learn to extract geometric elements based on site and functional demands, and realize the integration of formal innovation, rational logic and practical functions, achieving comprehensive improvement of design literacy.

5.2. Teaching reflections and optimization strategies

This training makes up for shortcomings of traditional teaching, yet further improvements are needed. Later courses can expand geometric application scenarios and launch special training for mountain, waterfront and urban renewal sites to enhance students’ problem-solving capacity in complex environments.

Besides, AI should be positioned as an auxiliary tool for analysis and scheme iteration rather than a direct generator. We can introduce peer review and scheme defense to strengthen students’ expression and critical thinking, forming a complete teaching closed loop.

6. Conclusion

Geometric forms are the basis of architectural design. Profound geometric construction skills and rigorous design logic are core qualities for architecture students. Faced with popular AI tools and defects in traditional teaching, undergraduate education ought to return to design essence and correct the bias of valuing form and tools over fundamentals and thinking.

This graded training targets senior students’ weaknesses and establishes a hierarchical closed-loop design system. Progressive tasks help students rebuild design cognition, consolidate basic skills and develop rational thinking. Practice proves that geometric training can standardize students’ design logic and spatial ability. It

provides an effective approach for basic architectural teaching reform and helps cultivate competent architects with solid skills, logical thinking, and innovation.

Disclosure statement

The author declares no conflict of interest.

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