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Designing With Medium: Exploring The Agency Of Representational Media In Architectural Design

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Abstract

This study attempts to elucidate the relative impact of the designated representational medium on architectural design knowledge during the design process. It focuses on the relationship between designers' cognitive processes and the revealed design information corresponding to different representational media.

The assertion here is that designing, specifically the act of representation, necessarily involves a medium and that representational media possess agency, which affects the information content available to designers during the design process. Designing is defined as a process of constructing representations, where the act of representing facilitates a reflective dialogue between the designer and the object of representation. This study's framework is aims to reveal the agency of representational media through a community of practice situated within shared sociocultural, and environmental contexts. The interaction between the designer and the media of representation is structured upon the theoretical model of–Activity Theory–, which provides a framework for analyzing human actions oriented toward specific purposes through instruments within particular conditions.

–Within the framework of the article, two workshop sessions were conducted, along with semi–structured interviews related to those sessions. The data derived from the interviews were examined using the reflexive thematic analysis method. Information content related to various representational media within the shared sociocultural and environmental context was revealed.

Keywords: mediation in design; agency in designing; representational media; representational determinism; representational knowledge.

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1. INTRODUCTION

This study seeks to elucidate the epistemic and cognitive implications of representational media in architectural design by investigating their impact on the generation, transformation, and communication of design knowledge. It foregrounds the active role of media in shaping design cognition through the act of representation, examining the intricate relationship between designers' cognitive processes and the information that emerges through various representational media. In this study, "representation" refers to the external articulation of design ideas through visual or material forms, while "representational media" encompasses the full range of media through by which such representations are produced . The term "mediation" is used conceptually to describe how these media shape cognition, perception, and action within sociocultural contexts, drawing on Activity Theory and Vygotskian perspectives on tool–mediated learning.

At its core, this research is premised on the assertion that design activity is inherently mediated by the act of representation through representational media and that these media are not neutral conduits of information but active participants in the structuring of design cognition. Design activity is framed as a process of constructing representations, wherein each medium affords distinct epistemic opportunities and constraints, fundamentally influencing how design information is framed, explored, and comprehended. In this regard, the act of representation is understood as a dynamic and iterative process of externalization and re–interpretation, fostering an ongoing reflective dialogue between the designer and the evolving design artifact, that is, representational knowledge.

To frame the investigation systematically, we employed the theoretical framework of Activity Theory to focus on human actions—the act of representation with the media of representation in this study—–that are mediated by artifacts, tools, and broader sociocultural conditions and environments. The study also engages with the notion of communities of practice (Wenger 1998 2–3), emphasizing how knowledge production is embedded in collective and culturally–situated practices rather than being an isolated, individual endeavor. Knowledge is understood to emerge through active engagement within specific social, cultural, and environmental contexts (Lave and Wenger 1991).

Empirically, the research is grounded in two workshopping sessions, followed by semi–structured interviews designed to capture the nuanced interplay between designers and representational media in situated design environments. The qualitative data, analyzed using the reflexive thematic analysis method (Braun and Clarke 2006, 2012, 2022), provide insights into how different media shape the encoding, articulation, and transformation of design information within shared sociocultural and environmental contexts. The findings reveal that each representational medium affords distinct cognitive and epistemic conditions, influencing how designers engage with ambiguity, iterate on design cognition, and construct meaning throughout the design process. These findings suggests that the epistemic functions of representation should be critically examined to foster more reflective, media–conscious design methodologies.

1.1 DESIGN RESEARCH AND COGNITION IN DESIGN

In the realm of architectural design research, a lineage of studies has endeavored to understand design through action and process, primarily focusing on its operational and procedural complexities. This lineage can be traced back to the 1960s and 1970s, when a distinct shift in design research studies led to three critical approaches to the understanding of design: The first is the Problem–Solving Approach that conceptualizes design as a staged process inspired by information–processing models, in which a clearly defined problem serves as the initial input for structured problem–solving (Alexander 1964; Simon 1969; Newell and Simon 1972). The second is the Interactive Problem–Solving Approach, which emphasizes the dynamic interplay between problem and solution. It frames design as an iterative, co–constitutive process in which designers continuously reframe and redefine the problem and its potential solutions (Schön 2017; Goel and Pirolli 1992, 395–429; Dorst and Cross 2001, 425–37). The third is the Discovery and Development Approach, which regards design as a space for exploration and emergence. Here, designers engage in reflective dialogue with both the problem and solution, using various tools and methodologies to uncover new insights (Cross 2006; Stolterman 2008; Tversky 2009, 201–16).

The ongoing evolution of these design research approaches aligns with advancements in cognitive science and psychology, particularly in understanding the environmental influences on mental processes (Kannengiesser and Gero 2019; Gero and Milovanovic 2020; Cash 2018, 118–45). These insights have refined design methodologies, expanding theoretical foundations (Hay et al. 2020), and reinforced the intrinsic connection between cognitive processes and representational mechanisms. However, despite extensive research on designers' use of representation, a significant gap remains in understanding the extent to which representational media actively shape and structure design cognition, rather than merely facilitating it.

This study challenges the instrumental view of visual representational media, instead conceptualizing them as autonomous cognitive agents that mediate and shape design processes. While previous research has examined mediational processes in terms of cognitive extensions of the designer (Oxman 1997, 329–47; Visser and Maher 2011, 213–20; Tversky 2014, 3–20; Scaife and Rogers 1996, 118–200; Goldschmidt 2007, 43–48), representation is often framed as a passive or neutral instrument for design thought. Similarly, studies investigating the role of representation in design cognition focus primarily on internal cognitive processes (Cash and Maier 2016, 118–125; Kavaklı and Gero 2001, 347–55; Badke–Schaub and Eris 2014, 353–60; Chafi 2014, 34–40; Goldschmidt 1994, 160–65) and the relationship between internal and external representations. More recent discussions extend this perspective, suggesting that representation is not merely an extension of cognition but rather a constitutive component of knowledge production, influenced by environmental conditions and constraints (Mao et al. 2020, 5–15; Cash and Kreye 2017; Tahsiri et al. 2017, 440–50).

Despite these advancements, there remains a critical need for research on how different representational media embody design knowledge and influence design cognition through their inherent structures within the community of practice. While prior studies have explored the relationship between design and representation, they have not fully examined the autonomous role of representational media in shaping cognitive processes through collaborative interactions.

This research diverges from existing approaches by emphasizing the cognitive impact of representation mechanisms, where representational cognition emerges through interaction between actors and representational media as collaborative production within the shared sociocultural and environmental contexts. Investigating whether representational media possess agency in shaping representational cognition within the community of practice and, if so, how this agency affects designers' cognitive processes is the main objectives of the research. We use the term "representational agency" to describe the active role that medium of representation—plays in shaping the cognitive trajectory of the designer. Rather than acting as neutral carriers of design information, these media afford and constrain how such information on representations is perceived, reasoned through, and articulated during the act of designing. Relatedly, we draw upon the concept of "representational determinism" (Zhang 1997), which posits that the structure of a representation can determine, to a certain extent, the type of strategies available, thereby shaping the trajectory of design thinking.

By comparatively mapping these interdependencies across different representational media such as site plan, floor plans, and section in this study, we aim to shed light on both how the inherent structures and limitations of various media affect designers' cognitive processes , and how different media afford design information and influence design outcomes.

2. THE INTERACTION OF THE SUBJECT AND THE MEDIUM

Research on the interaction between design and representation often highlights the dialectical relationship between representation tools and the designer (Schön and Wiggins 1992, 140–50; Goldschmidt 1991, 130–40). This dynamic exchange plays a critical role in design thinking, particularly in the early stages of the design process. As a result, contemporary research has adopted holistic approaches that emphasize the co–constitution of action and thought (Goel 1995; Schön and Wiggins 1992, 150–156; Goldschmidt 1991, 135–43), recognizing embodied knowledge and the iterative feedback loop between doing and thinking as fundamental to design. A core focus of these studies is how designers perceive and interact with their representations (Goldschmidt 1991, 130–35; Van Sommers 1984; Suwa & Tversky 1997, 385–403). This line of inquiry explores how designers think and how their representational outputs both reflect and influence design decisions (Oxman 1997, 330–40; Akin and Lin 1995, 215–225). Within this framework, the generation of design knowledge is understood not as a linear, systematic problem–solving act, but as an exploratory and iterative process shaped by subjective, dynamic interactions. Researchers have investigated this by focusing on design cognition, examining what designers do (Cross 2006), how they think (Lawson 1980), how they behave (Goel 1995; Goldschmidt 1991, 120–140), and how they construct meaning.As designers engage with problems and potential solutions, their actions and representations become central to an iterative process of discovery and exploration.

Design representations are not merely rational, conscious outputs, but emerge through complex interactions between mental processes and acts of representation (Milovanovic 2019). The representational mechanism plays a crucial role in uncovering otherwise invisible or unexpected insights, influencing design thinking, behavior, and cognition (Tversky 2014, 5–30). Rather than serving as a passive cognitive extension, representation operates as an autonomous agent, actively shaping the designer's cognitive processes and structuring thinking–in–action according to the affordances and constraints of the design environment. Research within this paradigm demonstrates that different representational forms encode distinct types

of information, and that designers employ similar forms of representation to express similar types of design knowledge (Do, 1995; 1997; 1998; Do et al. 2000, 483–503; Do and Gross 2001, 425–37). Studies linking representation and cognition further establish that representational mechanisms influence both individual productivity and modes of thought(Johnson 1998, 15–24; Goel 1995, 123–33; Goldschmidt 1994, 158–74). Additionally, research shows that different types of representation activate distinct cognitive strategies and actions (Badke–Schaub and Eris 2014, 363–70). The mediation process allows designers to externalize their cognitive processes, facilitating communication, re–interpretation, and re–production of design information in both individual and collaborative settings. In this way, representation renders mental processes visible, enabling the emergence of new insights and guiding designers toward progressive comprehension and refinement (Ullman et al. 1990, 263–74; Hewitt 1985, 2–9; Suwa and Tversky 1997, 385–403).

Building on this theoretical foundation, the next chapter examines how representational mediation shapes design cognition, emphasizing its role in structuring cognitive processes and facilitating knowledge production.

3. REPRESENTATIONAL MEDIA IN DESIGN

Representations serve as cognitive instruments, facilitating the explication of ideas and enabling information processing for internalization. These media mediate the interaction between internal cognitive structures and external design representations, shaping both content and constraints of action (Zhang and Patel 2006, 333–41). These interactions operate as a production system throughout the design process, where designers engage in a reciprocal feedback loop with representational media (Schön 2017; Lawson 1980). Essentially, representations created during design become the focus of design research, and the design process transforms into a series of actions involving the construction of representations (Visser 2010, 29–33). Consequently, designing can be viewed as a process of building representations (Visser 2006, 103–13), wherein evolving architectural thoughts and knowledge are externalized, refined, and reincorporated into the design process through repeated engagement with representational media. These media enhance both the capacity and scope of a designer's cognitive activity, allowing them to recognize, contextualize, and address design problems and solutions within the possibilities and limitations of the chosen or utilized medium (Dalsgaard 2017). The design process is inherently cyclical, with designers continuously assessing emerging conditions, integrating new insights, and constructing knowledge through iterative representations. Each act of representation, manifested through representational transformations, uncovers new information (Nelson and Stolterman 2014), which in turn reshapes the designer's mental model and cognition.

If designing is considered a process of constructing representations (Visser 2006, 103–13) with the specific purpose of transforming evolving architectural thoughts and knowledge into objects of representation, which are then reintegrated into the design process through representational media, it follows that designing involves a set of actions. These actions occur within specific conditions, situations, and constraints.

Representational media enhance both the capacity and scope of a designer's cognitive activity, enabling the perception and framing of possible design problems and solutions within the possibilities and constraints of the mediation tools (Dalsgaard 2017). The designer progresses through a cycle of re–evaluating the emerging situation and reintegrating insights into the design process. This iterative process, consisting of successive representations, reveals new information, and interaction with this information through mental processes generates new knowledge during designing.

Designing, understood as a set of actions that transform current situations into preferred ones (Simon 1969, 473–83) can occur in many different ways that gain meaning through context. These problems and solutions are produced by the designer–mediated through media of representation (Nelson and Stolterman 2014). Both the knowledge and the thought of design emerge within the dynamics of the context itself through actions that take place during the design process. These actions and operations during the design process, mediated by various instruments, enable the designer to encounter possible problems, propose solutions, and make discoveries through the representations produced with these instruments (Do et al. 2000, 483–93). The results of the designer's operations often take the form of external representations, which the designer then uses to continue the situation revealed through these representations. Through the act of representing, these representations provide the opportunity to transform information into different forms , offering varied perspectives on design problems and their solutions.

The final products of the design processes are not the design objects themselves, but rather the specifications of these objects as expressed in various representational forms. The transitions and transformations between representations are repeated until a final product is obtained. The designer's ability to perform these recurring actions and transformations is enabled by the relationship between internal and external representations. This cognitive construction process involves production, transformation, and evaluation

operations, continuing throughout the design process until a preferred state is achieved (Visser 2010, 33–43). The representational medium as a mediation instrument facilitates not only possibilities of interaction for designers with their mental processes but also the orientation of information content.

In this framework, the representational media is conceptualized as a relational structure influenced by cultural, physical, biological, and perceptual affordances that mediate the relationship between internal cognitive processes and externalized design representations (Gibson 2014, 56–60).

Affordances, as defined by Gibson (2014), are potentials that provide opportunities for action and guide the behaviors of perceivers. They are mutually constrained by both characteristics of the environment and those of the perceivers. Although perception is considered the most effective and direct way of knowing, there are different forms. He states that knowing through instruments, such as language, transforms knowledge from an implicit form into an explicit one. In other words, the mediation process depends on both the medium and the perceivers in transforming one form of knowledge into another. In this context, affordance is considered a practical approach not only for analyzing the possibilities offered by the environment but also as a useful framework for extending the object of study to a broader perspective that encompasses cultural processes. This mechanism not only facilitates the creation and communication of design information but also impacts the evaluation and refinement of design knowledge throughout the design activity. The interaction between individuals and their environment is facilitated by cognitive tools, whose structural and physical properties influence how they are used, perceived and interpreted. These tools are embedded within a sociocultural context, where accumulated knowledge and shared conventions shape their application (Wertsch et al. 2007). From this perspective, cognition is seen as a sociocultural construct that develops through higher–order cognitive activities (Vygotsky and Cole 1978), such as design thinking and the acquisition of representational knowledge through acts of representation mediated by the media of representation in this study.

Building on the role of representational media as cognitive mediators (Section 3), this study examines how these media shape cognitive actions through the theoretical lens of Activity Theory (Section 4). This expanded perspective accounts for both the affordances of representational media and the sociocultural dimensions of design activity, offering a more comprehensive understanding of how representation mechanisms structure design cognition.

4. ANALYZINGDESIGN COGNITION USING ACTIVITY THEORY

Activity Theory provides a framework for analyzing human actions as tool–mediated processes, in which individuals interact with instruments, artifacts, or representational media to achieve specific objectives within particular conditions. Within this framework, an individual's actions within a given context constitute a fundamental unit of analysis (Kaptelinin and Nardi 2007). Actions are not isolated but structured by the sociocultural environment, reinforcing the idea that cognition evolves through activities. Cultural tools such as language, symbols, and representations mediate this process, shaping both mental development and design cognition. Leontiev's (1974) approach to activity structures emphasizes the dialectical relationship between mental processes and mediated actions, asserting that tools expand cognitive capabilities while simultaneously imposing constraints based on affordances. This interaction forms an internal system of transformation and development in which cognition is dynamically shaped by external artifacts. In Engeström's (2015) expanded activity model, human activity is framed as a network of interactions occurring within a broader sociocultural system, where the subject, object, tools, and community interact through rules and the division of labor (Crawford and Hasan 2006; Vygotsky and Cole, 1978). These mediating tools encapsulate historical knowledge of how communities engage in and organize activities, reinforcing the relational structure of cognition and representation.

Expanding on Leontiev's object–oriented motivation and Vygotsky's mediated cognition framework, Engeström broadens Activity Theory by conceptualizing activity as a system of interconnected actions in which the subject actively participates in knowledge construction (Havnes 2010, 491–97). This study adopted Engeström's perspective to examine design as a mediated activity, with a particular emphasis on the act of representation in the design process. Building upon Engeström's framework, we examined the process of design—particularly the act of representation—as a mediated activity, emphasizing how artifacts and collaborative interactions influence cognitive processes. This model allows us to conceptualize design as an activity system in which various components interact dynamically: the subject (designer); tools (representational media); rules (disciplinary conventions); community (collaborative networks in the design studio); division of labor (roles in studio design practices); and object (external representations produced during the design process) collectively contribute to the production of an outcome that is representational knowledge in this study. Within this framework, the present study seeks to explore the relationship between designers and

their representational practices, demonstrating how knowledge emerges through iterative engagement with media and socio–cultural contexts.

Socio–cultural context refers primarily to the shared pedagogical environment in which all participants were educated. This encompasses representational conventions, representational practices, and feedback mechanisms embedded within the systems of design studios. Such sociocultural norms shape how designers engage with representational media, influencing their choice of tools and their understanding of legitimate design knowledge. While broader cultural factors—such as architectural canons—are acknowledged, the analysis centers on the micro–culture of design education as the primary contextual framework. Activity Theory conceptualizes human behavior as a hierarchical structure composed of motive–driven activities, goal–directed actions, and condition–dependent operations (Leontiev, 1974 4-7). In the context of this study, the activity is the act of architectural designing; the action is the act of representation; and the operations are the cognitive moves made under specific given conditions.

5. COMPARISON OF COGNITIVE PROCESSES THROUGH REPRESENTATIONAL MEDIA

This study employed an action research methodology, utilizing workshops as case studies to examine participants' cognitive processes in the context of design cognition. The workshops functioned as iterative cycles of observation and interpretation, where participants' engagement with different representational media is analyzed through semi–structured interviews. This approach enables a nuanced investigation of representational agency, capturing how various media influence designers' cognitive processes. The workshop–based qualitative framework underscores the necessity of structured environments that replicate real–world design processes, and allow for systematic observation. To establish a controlled, yet contextually relevant setting, participants were deliberately selected from recently graduated architects who had previously shared a common studio environment during their education. This ensures a common experiential foundation through the shared sociocultural context and its conventions, facilitating a more reliable comparative analysis of cognitive engagement across different media within the community of practice.

The study involved six participants—recent graduates from a four–year undergraduate architecture program—and aligned with established qualitative research practices in design cognition. The aim was not statistical generalization but an in–depth examination of cognitive processes within a defined community of practice. All participants had completed four years of design studio education at the same institution, ensuring a consistent familiarity with conventional representational practices. This shared background offered a coherent framework for analyzing the cognitive influence of representational media. However, the study is limited by its reliance on two workshop sessions and a small, homogenous participant group. While suitable for in–depth qualitative exploration, these constraints preclude generalizable conclusions. All participants shared a common educational background within a single studio pedagogy, which ensured consistency for representational comparison but potentially shaped their representational practices. These findings underscore not only the cognitive role of representational media but also the influence of embedded pedagogies that mediate their use. Future research should involve participants from diverse pedagogical contexts to further evaluate the robustness and applicability of the theoretical framework.

Two workshop sessions were conducted as case studies, each with six participants. The aim was to compare the cognitive processes of designers and the diverse representational media they used in their design work. The information conveyed by each representational medium at different stages of the design process was analyzed to determine whether representational agency—that is, the medium's influence on designers' information processing—is present. The workshop was designed to elicit contrasting cognitive strategies through two design tasks. The first task, which imposed functional constraints, aligns with problem–driven reasoning, in which designers operate within structured parameters (Dorst and Cross 2001, 425–37). In contrast, the second task, which emphasizes conceptual exploration, corresponds to solution–driven reasoning, in which designers rely on intuitive synthesis rather than fixed constraints (Goel and Pirolli 1992, 395–429). In the first design task, participants worked on designing a house on a plot that has restrictions which are border walls for the site and built area. In the second design task, participants were asked to design a pavilion in a plot with no restrictions and requirements for the site and built area.

Participants were provided with fundamental site information, including the site photographs and building restrictions. Freehand drawing was encouraged as the primary design tool, though participants were free to incorporate any representational media relevant to their process. To maintain an unbiased process, the participants worked independently, without external input or researcher intervention

Following each design session, all design proposals were analyzed to track transitions between representational media. Subsequently, semi–structured interviews

asked participants to recall their cognitive processes while creating specific representations. The interview questions explored the reasoning behind producing each representation and the necessity of transitioning between different representational media in their design process. These interviews provided in–depth insights, allowing participants to reflect retrospectively on their design cognition. . The workshops were designed to facilitate shifts between representational media, allowing for a comparative analysis of cognitive engagement across various representational media.

The collected data were analyzed using Reflexive Thematic Analysis (Braun and Clarke 2006, 77–101; 2012; 2022), which facilitates an in–depth exploration of how designers engage with different media by systematically categorizing emergent themes and cognitive processes linked to representational agency, ensuring both comparative and interpretative validity in identifying emergent cognitive patterns. This method involves an iterative coding process through six stages: familiarization with data, generation of initial codes, identification of recurring themes, refinement and validation, conceptual articulation, and final synthesis. Given that qualitative research prioritizes theoretical saturation over large sample sizes, six participants were deemed sufficient to capture recurring cognitive patterns while maintaining a depth of insight into design cognition.

Each participant's data was transcribed, coded, and synthesized to define common themes associated with representational cognition to facilitate the identification of cognitive patterns. The information revealed by each representational medium was systematically compared across participants to identify both commonalities and divergences in how different media contribute to design cognition. This comparative framework provides deeper insights into the role of representational agency, clarifying whether and how the medium of representation shapes the information designers use during the design process.

5.1 FINDINGS: STRUCTURAL VARIANTS OF REPRESENTATIONAL COGNITION

Building on the procedural approach outlined in the previous section, this analysis focuses on the structural characteristics of representational cognition. Through a comparative examination of interviews and design processes, participants' representations across two design tasks were analyzed to uncover the informational content revealed by different representational media. The primary focus aim is to elucidate designers' cognitive processes by exploring the relationship between operation, action, and activity. By analyzing interviews, we identified the representational knowledge embedded within different media and mapped the cognitive processes of each participant.

The analytical framework utilized to interpret interview-derived data, aimed at uncovering the designer's intent when engaging with diverse representational media, is structured according to Leontiev's three-tiered hierarchical model of activity. This theoretical framework views human action as a multi layered system of interrelated goal-directed activities, each operating within a larger sociocultural environment. This hierarchical schema, frequently shown as a pyramid, defines three different yet interrelated levels that characterize human interactions with tools, objects, and environments:

- Activity, which in this study refers to designing, is driven by a motive. At the highest level, activity constitutes the most abstract and overarching dimension of human engagement, encompassing purposeful and socially embedded practices. It is guided by a motive that represents a fundamental need or overarching objective rather than a specific, predefined goal. Leontiev characterizes activity as a macro-level process in which individuals or collectives engage in actions shaped by broader sociocultural imperatives rather than immediate operational objectives (Leontiev, 1974).

- Action, which in this study refers to the act of representation, is driven by a goal. The intermediate level, action, encompasses intentional and goal-directed acts that are part of larger activities. Goals, unlike motives, are purposefully expressed and pursued, allowing individuals to dynamically adapt their activities in response to changing conditions or newly obtained knowledge. Engeström builds on Leontiev's framework, demonstrating how actions, while subordinate to activity, are necessary for achieving higher-order goals within structured systems of mediated practices (Engeström, 1987).

- Operation, which in this study refers to cognitive operations with media, is driven by conditions. At the most fundamental level, operations are composed of automatized or habitualized processes that are dependent on external factors and carried out without conscious cognitive decision-making. These routine activities emerge from repetition and procedural efficiency, allowing individuals to focus on higher-level goals without devoting cognitive resources to low–level execution. Operations are defined as preconscious and reactive behaviors that enable the seamless execution of goal-directed actions within changing environmental constraints. This hierarchical model is particularly valuable in elucidating the cognitive and procedural

dimensions of designers' interactions with representational media, offering insight into how intent and habituation collectively shape the design process. By articulating the interplay between motive-driven activity, goal-oriented actions, and condition-dependent operations, the framework provides a refined understanding of the cognitive structuring of design practices within architectural representation.

Comparisons were made across three major representational categories—site plans, floor plans, and sections—based on the case studies. These comparisons are summarized and visualized through diagrams, each illustrating participants' interview responses alongside their corresponding cognitive operations and actions. Responses are labeled according to participant number and design task sequence (e.g., P4.1 refers to Participant 4's response in Design Task 1).

While all three media contribute to design-related cognitive processes, their functions and mechanisms diverge due to their unique affordances and constraints, which shape the content and depth of information revealed during the design process.

Figure 1 presents a schematic visualization of designers' cognitive patterns when engaging with site plans. This figure supports the claim that site plans uniquely foster contextual comprehension by foregrounding external environmental features as primary design inputs. It outlines the sequence from contextual environmental analysis to conceptual design development. For instance, most participants began by identifying spatial affordances and then translated these observations into spatial relationships.

Participants who used the site plan as their primary design medium in the designprocess focus on contextual awareness through analyzing environmental features. They identified spatial patterns in the existing environment to generate and explore spatial and conceptual relationships that contributed to contextual comprehension. . Contextual comprehension is actualized by exploring and developing spatial solutions and their relations through information gathered by analyzing the environment. Their cognitive processes revealed a collaborative, iterative approach driven by the intent to understand the physical context and to create meaningful spatial and conceptual relationships that enrich the design environment (Figure 1).

Participants' process began with contextual analysis, interpreting environmental cues to shape initial spatial decisions, as reflected in participant statements highlighted in Figure 1 (e.g., P4.1, P3.1, P5.2, P6.2, P2.1, P2.2, P5.1, P6.1). The diagram illustrates how designers initiated their processes through contextual exploration, using environmental data to structure early spatial decisions (e.g., P1.1, P5.1, P2.2, P6.2, P2.2, P5.1, P6.1). Their design cognition was driven by the motive to develop a deep understanding of the site's physical and social conditions and to translate these observations and environmental features into spatial strategies that align design elements with site features.

When participants employed the plan as their design medium,, the attention of the designer shifted toward elaborating the design, clarification spatial formations, and developing functional relationships. These actions involved determining, defining, and developing conceptual decisions and spatial functional features. Their cognitive processes revealed an iterative search driven by the motivation to increase the level of detail, refine conceptual decisions and creating well-defined, functional spaces to evolve design solutions (Figure 2).

Figure 2 illustrates how designers employed the plan as the medium to guide functional and spatial organization by highlighting the cognitive progression. Participants used this medium to clarify spatial hierarchies (P3.1, P2.2, P3.1, P4.1) and to define programmatic functions and spatial integrations (P2.1, P5.1, P5.2, P3.1), as revealed in the portions of their statements highlighted in Figure 2. Unlike the contextual emphasis of site plans, the plan encouraged a more analytical mindset focused on internal organization, spatial arrangement, and refinement. This translated abstract ideas into structured layouts, ensuring logical spatial sequences. As such, Figure 2 demonstrates the plan's role as a cognitive scaffold, supporting spatial clarity, iterative reasoning, formal resolution, and the articulation of design intentions.

Participants using section as a medium in the design process prioritized the comprehensive exploration of conceptual and spatial relationships by refining spatial arrangements. These processes were realized through the interaction and evolution of spatial relationships and arrangements to explore the multidimensional features of space. Their cognitive processes reveal an iterative search driven by the motivation to develop decisions that consider organizing concepts and spatial relationships in order to shape related spatial experiences (Figure 3). Figure 3 maps the cognitive strategies of designers utilizing section in design activity to explore spatial experience. Participants' answers show that section drawings revealed previously unnoticed spatial qualities, as highlighted in Figure 3 (e.g.,P3.1, P2.1, P6.2), and prompted reevaluation of atmosphere and experience (e.g., P1.1, P1.2, P2.2). This medium supported reflective engagement, allowing designers to perceive the embodied effects of their proposals.

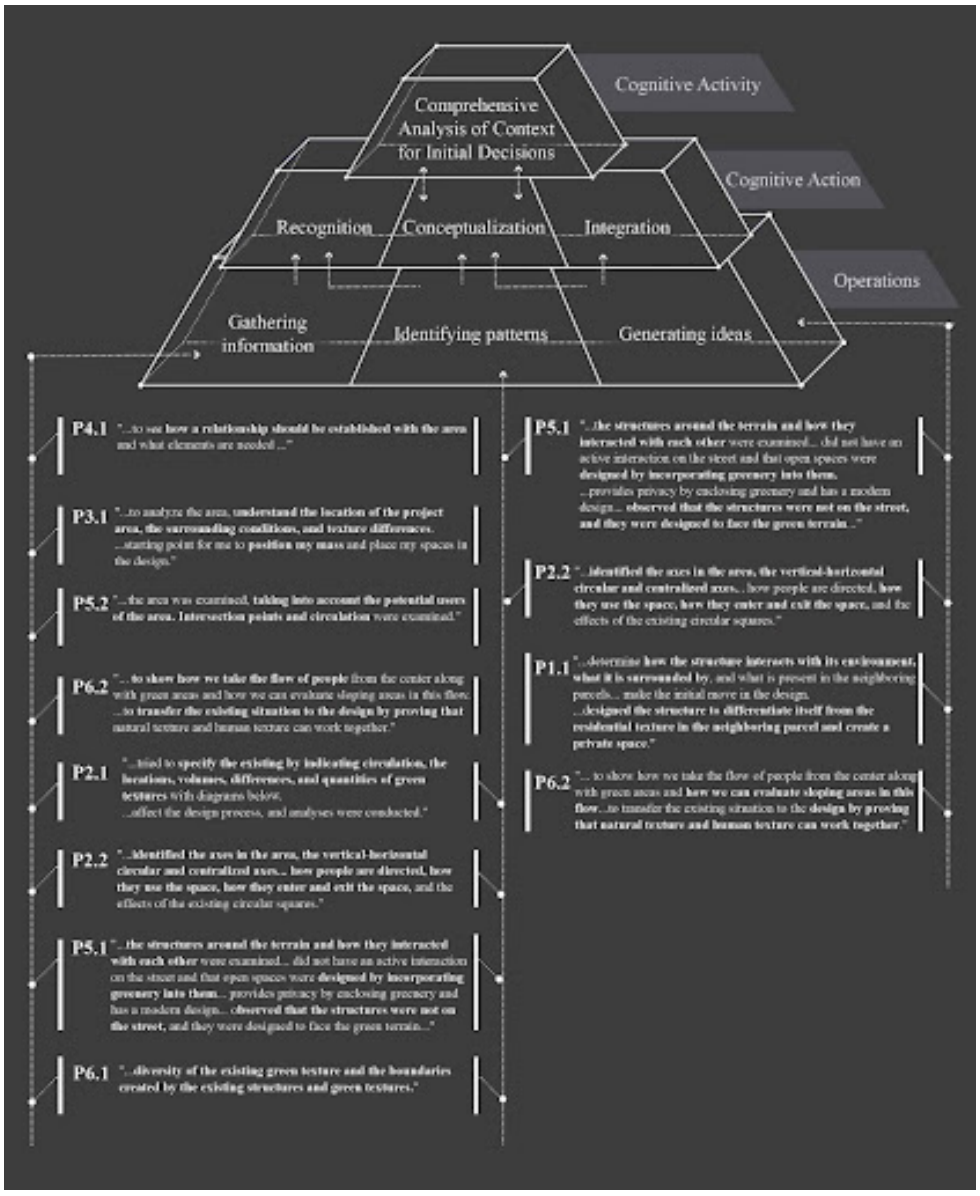

Figure 1. Cognitive structure of the designers using the site plan as a medium of representation.

In this context, Figure 3 demonstrates that the section acts functions as a generative representational mechanism—not merely for clarifying geometry, but also for provoking new spatial experiences.

5.1.1 Common Ground for Representational Cognition Structures

Across all three representational media–site plans, floor plans, and sections–designers engage in shared cognitive processes that involve:

- Gathering information and understanding spatial relations and interactions related to the designed object and its context.
- Analyzing the problem and solution space through representations with varied intentions, in order to explore and identify patterns and relations for decision–making.
- Exploring and refining design decisions based on insights gained from spatial relations.

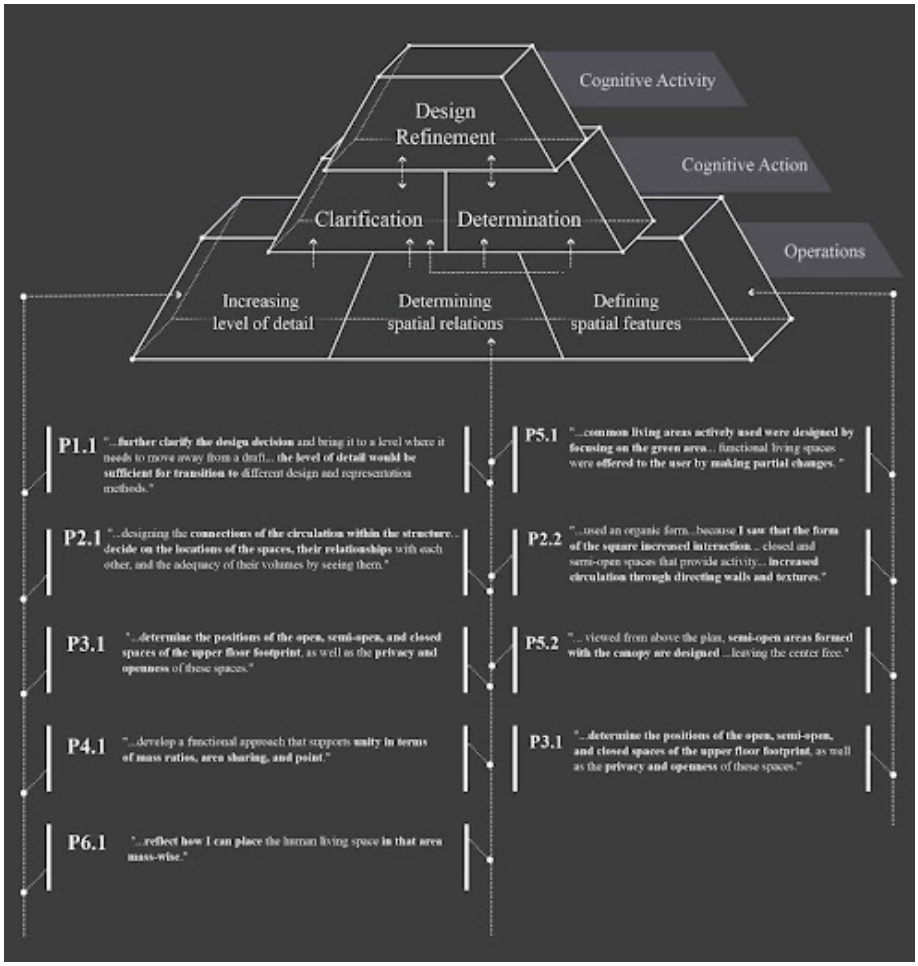

Figure 2. Cognitive structure of designers utilizing plan as medium of representation.

5.1.2 Diverging Paths of Representational Cognition Structures

While all three media facilitate the externalization of design cognition, they structure information and support cognition in distinct ways. Site plansforeground environmental and contextual awareness,;plans reinforce functional articulation and refinement,;and sections activate experiential reasoning and spatial depth. These differences are not incidental but stem from the inherent affordances of each medium, reinforcing the concept of representational agency. Designers shift between these media not arbitrarily but to engage different modes of knowing, suggesting that representational transitions function as cognitive thresholds within the design process.

Despite the shared common ground, each medium possesses distinct characteristics and functions:

- Site plans serve as tools for understanding the environmental context. Designers use them to examine surrounding features and identify factors that influence design decisions. Site plans transform information

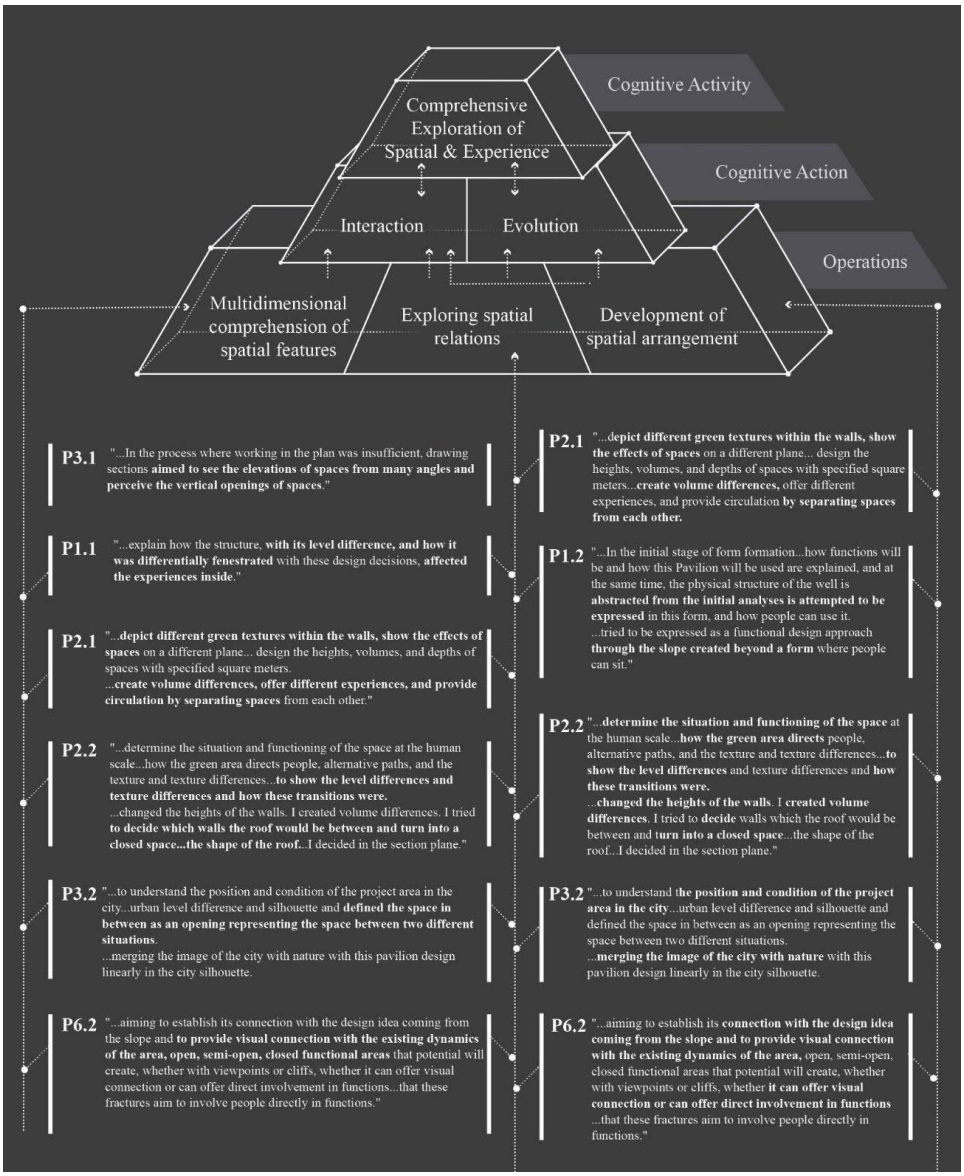

Figure 3. Cognitive structure of designers utilizing section as medium of representation.

gathered from existing conditions and transfer it into the solution space to generate design ideas.

- Plans, on the other hand, focus on clarification of decisions and the refinement of spaces and their integration. They allow for detailed exploration of relationships and support the development and manifestation of spatial functionality.

- Sections function as instruments for comprehensive spatial exploration, enabling the refinement of spatial relationships and creating immersive experiences.

6. CONCLUSION: THE AGENCY FOR REPRESENTATION MECHANISMS

This study explores the relative impact of representational mechanisms on the informational content utilized by designers during the design process. While previous research has established that representation significantly influences cognitive processes, this study advances the discourse by illustrating how each representational medium actively shapes cognitive frameworks, reinforcing the concept of representational determinism. The findings highlight

that different representational media afford distinct cognitive operations and actions, thereby structuring the trajectory of design cognition in a unique and non-arbitrary manner. Through the lens of the hierarchical model of Activity Theory, this study maps how design cognition is structured by representational choices, distinguishing between motive-driven activity, goal–directed actions, and condition-dependent operations.

The comparative analysis of cognitive processes across different representational media in the previous section demonstrates that designers engage in distinct yet interconnected forms of reasoning, shaped by the affordances and constraints of the medium used. The results underscore that representational mechanisms not only facilitate specific cognitive actions and operations but also constitute an essential component of the designer's epistemic repertoire. They enable knowledge acquisition through action, as designers construe the structures of information differently when utilizing diverse media. This leads to distinct cognitive operations, and transitions between media function as cognitive thresholds—points at which designers must reinterpret, refine, and restructure design knowledge at each stage.

This perspective aligns with the constructivist understanding of representational media as active participants in the cognitive process. A key objective of this research has been to reveal the inherent informational content embedded within different representational forms and to analyze the cognitive mechanisms that are activated during their use. Transitions between representational media are conceptualized as liminal spaces, positioning designers in an intermediate state between explicit and implicit representation. Each medium acts as a cognitive gateway, compelling designers to navigate varying levels of abstraction and comprehension. In doing so, they foster negotiation and reinterpretation through the embedded knowledge each representation carries.

Given that the design process inherently involves continuous transitions between multiple representational media, these intermediate phases function as cognitive thresholds that enhance designers' cognitive awareness. This study asserts that representational agency is intrinsically linked to the specific affordances of each medium, with particular focus on site plans, plans, and sections. Each representational format imposes unique constraints and possibilities, thereby reshaping the designer's cognitive engagement and problem-solving strategies.

Furthermore, the analysis of the operational structures of various representational media—specifically site plans, plans, and sections—offers an additional contribution to the field by revealing how each medium both enables and constrains cognitive processes during design. The findings reinforce the argument that representation is not merely a passive cognitive tool but an active structuring agent that influences design thinking by imposing distinct cognitive limitations, thereby further solidifying the concept of representational determinism. Moreover, the transition patterns observed during design workshops suggest that designers do not select representational media arbitrarily; rather, their choices are shaped by the inherent affordances of each medium, which in turn dictate the cognitive processes they engage in.

This further indicates that representational agency is not purely a cognitive phenomenon but is deeply embedded in sociocultural contexts. Representational media are shaped by historical conventions, disciplinary practices, and shared epistemic traditions, which in turn influence how design knowledge is structured and transmitted. This transmission is mediated through social interaction and institutional frameworks, reinforcing the idea that design cognition is shaped not only by individual cognitive strategies but also by socially constructed information structures. These representational media help define what is recognized as legitimate design knowledge.

The influence of representational media on designers' cognitive processes opens avenues for future research, expanding the insights established in this study. These findings have direct implications for both architectural education and professional practice. In design studios, educators should emphasize the deliberate selection of representational media, fostering an awareness of how different media shapes cognitive engagement and design reasoning. In professional contexts, a deeper understanding of the affordances and constraints of various representational techniques can inform strategic design workflows and representation-driven ideation.

A more granular examination of the specific affordances and constraints associated with each representational medium across different sociocultural environments could further clarify how their distinct characteristics influence design outcomes. This knowledge can support a more intentional application of representational tools in guiding and shaping architectural thinking. Moreover, integrating an awareness of representational mechanisms into architectural education, particularly within design studios, holds immense potential. By recognizing representational media as autonomous agents in the cognitive process, this study contributes to a broader discourse on the materiality of cognition in architectural design. Acknowledging the embedded knowledge within different representational media empowers designers to engage in their creative

processes more consciously and purposefully, ultimately refining their ability to conceptualize and articulate design ideas with greater precision and depth.

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