From Conversation Theory to Architecturology. Towards a Systemic Metatheory of Conceptual Reasoning

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Abstract. This study examines three distinct theoretical frameworks. First, following the events of May 1968, a shift occurred between first- to second-order cybernetics, during which systems thinking emerged as a transdisciplinary framework for modelling dynamic structures and processes. Second, in 1969, Gordon Pask, a pioneer of cybernetics and emerging artificial intelligence, suggested that cybernetics could serve as a metalanguage for architecture. His Conversation Theory provides an externalist lens for examining dialogue, learning, and collaborative conceptual processes. Third, in 1971, Philippe Boudon initiated Architecturology, an emerging science aimed at formalizing architectural reasoning through conceptual models, using an internalist approach. Although distinct in origin and orientation, these three frameworks converge in their focus on the modeling of conceptual processes. A direct comparison between Conversation Theory and Architecturology remains limited, as they address different phenomena: learning and understanding in Pask's externalism, and design reasoning in Boudon's internalism. However, by mobilizing general concepts of systems thinking as a common metalanguage, this research aims to identify convergences, divergences and potential complementarities. The method consists of a systematic conceptual analysis, positioning systems theory as a meta-framework that bridges Pask's externalist view of interaction and Boudon's internalist view of reasoning. Practically, the study applies a selected set of systemic concepts to both theories to assess their structural and dynamic correspondences, offering a new perspective on the formalization of theoretical models. The findings reveal previously unexplored conceptual interactions at a meta-level: despite their disciplinary distance, both theories rely on shared systemic mechanisms, demonstrating that systems thinking can function as a metatheory for modelling conceptual reasoning.

Keywords: System Thinking · Conversation Theory · Architecturology

1 Introduction

In the intellectual climate of the late 1960s, three major theoretical models emerged almost simultaneously in distinct disciplinary contexts: (1) In the United States, Ludwig von Bertalanffy's General System Theory [1] proposed a framework for modeling open

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interacting systems. (2) In the United Kingdom, Gordon Pask developed Conversation Theory [2], to model processes of learning and co-construction of meaning. (3) In France, Philippe Boudon established Architecturology formalizing architectural reasoning and design operations [4].

Although developed independently, these frameworks share a common ambition: improving our capacity to model complex conceptual processes. However, they operate at different levels: systems theory provides a general framework for modeling complex systems; Conversation Theory formalizes the cognitive processes distributed across conversations and interactions from an externalist standpoint; while Architecturology develops an internalist approach to design reasoning. This leaves their potential complementarities largely unexplored and raises questions of how a dialogue between them could enrich the modeling of conceptual processes.

As early as 1969, Pask outlined a response by proposing cybernetics as a metalanguage for architecture [5], set against the backdrop of his ongoing theoretical work. Building on this intuition, the present study asks whether systems thinking, evolved from first- and second-order cybernetics, can function as a metalanguage capable of connecting Conversation Theory and Architecturology by revealing shared organizational logics.

While the two theories might appear incommensurable, given that conceptual processes are traditionally studied either from an external or an internal standpoint, the very fact that such processes necessarily involve both dimensions suggests that systemic concepts, partially embedded in each, may provide a bridge. The central hypothesis is therefore that systems thinking can function as a metalanguage capable of revealing common organizational logics and structuring mechanisms underlying both frameworks. We aim to test this possibility through a conceptual comparison based on a selected set of systemic notions. Through this approach, the paper develops a comparative meta-framework that treats theoretical models as systems, analyzed through their structures, dynamics, and emergent properties. It tests the potential of systems thinking as a cross-disciplinary framework and advances a systemic understanding of conceptual reasoning as a recursive, emergent, and adaptive process common to both learning and design. Ultimately, this study goals to clarify the epistemological status of systems thinking as a metatheory of modeling and suggests its relevance for design research, pedagogy, modeling, and the development of artificial intelligence systems capable of representing conceptual reasoning as a dynamic and adaptive process.

1.1 General System Theory

Cybernetics, initiated by Norbert Wiener [6], initially established as a transdisciplinary framework for analyzing regulation and control in finalized systems. It enabled the formalization of key notions such as feedback, homeostasis, and self-regulation, yet has shown its limitations in accounting for the emergence of new finalities or the internal transformation of cognitive structures.

Second-order cybernetics [7–9] broadens this framework by introducing reflexivity, self-organization and co-construction of meaning, in which the observer is an integral part of the process. In parallel, Bertalanffy's General System Theory [1] defines a system as a set of elements interacting with their environment, open and goal directed. These contributions converge towards a systemic approach describing dynamic, multi-level systems capable of evolution and integrating the observer into the modeling process.

During the 1970s, these perspectives diversified for example: Forrester formalized system dynamics; Pask advanced Conversation Theory to model cognition and learning as dialogical and adaptive processes; and Le Moigne [10] developed an epistemology of modelling emphasizing the reflexivity of science. This extension of cybernetics into systems thinking seems particularly relevant for architecture, where design cannot be reduced to optimization but instead constitutes an evolving process in which purposes and structures are continually redefined.

Cognitive science and artificial intelligence have expanded this framework: symbolic AI has provided a means to formalize knowledge, while connectionist and emergent approaches have better accounted for creative and distributed dimensions. The dialogue between systems thinking, cognitive science, and AI thus informs a contemporary reflection on the modeling of thought systems, seeking to represent not only external behaviors or structures, but also the dynamics of reasoning, the evolution of models, and the recursive nature of conceptual processes.

1.2 Conversation Theory

By the late 1960s, the development of early computer-aided design (CAD) tools aroused interest, particularly at MIT and Cambridge, in applying cybernetics to architecture, which was considered as an information and feedback system. Pioneer of second-order cybernetics and early artificial intelligence, Pask explored intersections between cybernetics and art, taught at the AA school in London, and collaborated on architectural projects such as Fun Palace and Architrainer, where buildings were envisioned as interactive systems engaging with their users [11]. In The Architectural Relevance of Cybernetics [5], he argues that cybernetics can constitute a metalanguage for architecture, making it possible to model the complexity of human behavior and social systems. The architect becomes a designer of complex systems and the building an interactive actor, promoting adaptive regulation and self-organization of the architectural and urban project.

Pask thus reconceived design as a dynamic process of interactions and feedback, employing cybernetic models to integrate use, context, and behavior. The designer is integrated into the designed system and controls the construction of control systems. This reflexive dimension grants architecture a predictive and adaptive potential, oriented toward simulating and anticipating future interactions. Architecture is understood as a conversational system in which intentions, uses, and constraints intersect, with cybernetics functioning as an orchestrating metalanguage. This approach anticipates the importance, in Pask's later work, of the conversational and interactive dimension of cognition. Although Pask did not explicitly develop this intuition further, his subsequent theories, notably Conversation Theory and Interaction of Actors Theory, can be reinterpreted as constituting a systemic and constructivist framework.

Conversation Theory [8] formalizes knowledge as the outcome of reflexive conversations between human or artificial agents, distinguishing between communication (the exchange of information) and conversation (the co-construction of meaning). Conversational systems are structured through conceptual networks (*meshes*) that integrate declarative and procedural knowledge, continuously adjusted through feedback. Each participant is conceived as a self-adaptive system that maintains internal coherence and individual strategies, which in turn shape the integration of new information. Three levels of language structure the processes of validation and metacognitive adjustment: natural language (spontaneous construction of representations), object language (focused on the object of study), and metalanguage (reflection on the conversation itself). This dynamic relies on metacognitive feedback, illuminating both the content and the transformations of knowledge. Practices such as teachback, in which the learner reformulates knowledge to test and consolidate understanding, emphasize the emergence and transformation of knowledge rather than the mere production of finished outputs. This fosters the continuous adaptation of cognitive strategies and structures [12]. In the 1990s, Interaction of Actors Theory [3] extended this approach to collective systems and networks of actors. This work provides a framework for understanding architectural design as a process of interaction and adaptation, both individual and collective.

1.3 Architecturology

In parallel, Philippe Boudon, architect and professor at the national superior schools of architecture form "Paris-La Villette" (ENSAPLV) and "Nancy" (ENSA-N), founded Architecturology, which aims to formalize architectural reasoning as a scientific subject. Drawing on structuralism and linguistics, he conceived design as a formal system of rules, transformations, and cognitive operations, distinction it from its material manifestations. According to Boudon, Architecturology should be understood in the same way that linguistics is distinguished from language itself: not as architecture, but as the science of architectural design [4]. Architecturology adopts a constructivist perspective: understanding design does not consist in reproducing a tangible result, but in methodically formalizing the reasoning behind design. It thus studies 'the architecture of architecture' [4]. Two founding postulates structure this approach: (1) The design postulate, according to which architecture cannot be considered independently of its design [4], distinguishing the 'design space' (intentions and cognitive operations) from the 'real space' (the concrete product). (2) The measurement postulate, according to which any project involves situated and contextualized measurements, articulating design and realization through the trialectic of measuring, measured and relevance. Relevance, in this framework, is not absolute but depends on context, the designer's intentions, and the chosen frame of reference.

At the core of Architecturology lies dynamic modelling of reasoning, centered on two key concepts: the model (M), an operand that guarantees consistency and continuity, and the scale (E), an operator that introduces appropriate transformations and measurements, enabling adaptation and differentiation [4]. Reasoning is thus formalized as follows: E(M) = M', where the model evolves from the initial substrate to the final

model. Scales interact through overdetermination or juxtaposition, ensuring the articulation between intentions and project. Relevance expresses the contextual justification of choices, revealing the designer's creative freedom given real constraints.

Operations are based on a logic of measurement allocation, ensuring the connection between the design space and the real space, between the architect's intentions and the project. Three core operations are involved: referencing (selecting a reference), partitioning (defining a dimension), and dimensioning (assigning a value). Pertinence expresses the contextual justification of these choices, highlighting both the intentionality and the creative latitude of the designer when faced with real constraints. By distinguishing between classes of scales (technical, symbolic, geographical, etc.) and their 'scalemes' (contextualized instances of scales), Architecturology provides a rigorous framework attentive to the complexity and indeterminacy of design. It unfolds along two dimensions: a fundamental dimension, which establishes the general theoretical framework [4], and an applied dimension, tested through empirical case studies [13].

In this context, Architecturology proposes an internal formalization of architectural reasoning, centered on the cognitive operations of the designer, while Conversation Theory highlights the interactional and communicational dimension of learning processes. Both accord a central place to symbolic representations, conceptual language and cognitive dynamics, viewed as a non-linear, emergent and contextual process, structured by constant interactions and adjustments. Although they stem from different contexts and rely on distinct methods (one illuminating the internal structuring of conceptual processes, the other its external dynamics) they converge toward a shared theoretical horizon. This raises the question: can a systemic framework, as a cross-disciplinary metalanguage, enable these distinct approaches to be analyzed and connected?

2 Methodology

The analysis is based on a conceptual comparison. It consists in defining a set of concepts derived from systems thinking and examining their respective uses in two theoretical frameworks: Conversation Theory and Architecturology. The aim is to identify similarities, differences, or relationships despite their disciplinary distance. To ensure analytical rigor and cross-domain comparability, the systemic concepts were selected according to explicit criteria such as universality, cognitive relevance, and functional representativity, enabling capturing the structural, dynamic, and emergent properties of conceptual systems.

A key challenge lies in determining what can legitimately be compared, given the very different contexts in which these theories emerged and developed. Conversation Theory models externalist processes of learning and interaction, while Architecturology models internalist reasoning in design. Their direct disciplinary comparison would therefore be of little relevance. Systems thinking is introduced as a metalanguage that provides a shared conceptual apparatus through which both theories can be analyzed at a comparable level. In order to undertake such a study, the methodology follows three main steps: (1) Defining a common analytical level for both theories, enabling parallel examination of their internal dynamics beyond disciplinary differences; (2) Selecting

the systemic concepts according to explicit criteria ensuring their relevance for describing the systemic properties of each theory; (3) establishing the analytical procedures by which the comparison is conducted.

This approach is expected to shed light on the relevance of using these three theories, whether fully, partially, or independently, in the modeling of conceptual processes.

2.1 Defining the Analytical Level

To conduct this analysis, we distinguish several levels of cognitive apprehension: (1) paradigm, the meta-theoretical and epistemological framework that guides how a set of phenomena can be conceptualized; (2) theory, a more explicit conceptual system oriented by a paradigm, organizing notions to describe and explain a class of phenomena; (3) model, a more circumscribed and operational representation of a theory applied to a specific subset of phenomena; (4) method, an organized set of procedures and approaches linking theory to empirical observation; and (5) action, the level at which generated knowledge is translated into intervention within the phenomenal world.

This distinction draws on multiple epistemological traditions. Steinbruner [14] differentiates paradigm, theory, and model in a hierarchy from the most general to the most specific, defining a paradigm as a set of fundamental, often implicit assumptions that guide the production of theories and models. A theory constitutes a more explicit, yet still general, formalization, whereas a model represents the most specified and operational form, often corresponding to a concrete application of a theory. Method, in turn, has been defined as the interface between theory and empirical data: Le Moigne [10] emphasizes its function as an operational translator, while Bunge conceives it as an 'applied epistemology' [15], a set of rules guiding scientific construction and validation. Action is rooted in constructivist epistemologies, which consider knowledge not only as a description, but also as an intervention that transforms the observed system. For Piaget [16], action drives knowledge, since action schemes structure thought. Varela [17] extends this idea through the notion of enaction, in which action and perception continuously co-construct subject and environment. Action thus emerges not as a mere technical application, but as a constitutive dimension of knowledge and modeling.

This framework allows us to clarify both the status of each theoretical level and their relative position within the scientific landscape (Table 1).

Table 1. Theoretical levels of analysis

	System thinking	Conversation theory	Architecturology
Paradigm	x	no	x?
Theory	x	x	x
Model	x	x	x
Method	x	x	x?
Action	no	no	no

As shown in Table 1, Systemics operates at the paradigmatic and theoretical level, providing a transversal framework for structuring diverse knowledge and defining general principles (e.g., open systems, feedback, emergence). It extends to the levels of modeling and methodology (simulation, representation of complex systems) but does not function directly at the level of action: it produces conceptual tools, rather than tangible artifacts.

Conversation Theory asserts its position at the theoretical and the modelling level, formalizing dialogic interactions and learning processes. It embodies a strong methodological dimension, implemented through educational and experimental setups that operate its principles in pedagogical and communicative contexts. It does not constitute a full paradigmatic framework, even though it is grounded in second-order cybernetics and provides a vision of communication and learning processes, nor does it operate at the level of material action, focusing instead on the co-construction of knowledge.

Architecturology combines scientific theoretical dimension and design operations modeling. It does not constitute a global paradigm, but nevertheless claims a partial paradigmatic dimension, insofar as it is part of an interdisciplinary dialogue and asserts its own scientific nature. It operates at the theoretical level (postulates of measurement, relevance, scales) and at the model level (formalization of operations, conceptual structures, scales), with a methodological component (tools for case analysis and pedagogy). It does not directly produce architectural projects; its role is to formalize the reasoning that underlies them.

This paper focuses on the model level, where both Conversation Theory and Architecturology operate as operational modelling systems, one modeling learning and interaction from an externalist perspective, while the other formalizes design reasoning from an internalist lens. Their parallel becomes clearer when examined through their internal systemic dynamics rather than their disciplinary contexts.

Systemic thinking is mobilized not as a competing model, but as a meta-theoretical framework providing a cross-disciplinary conceptual language (system, flow, feedback, emergence, etc.) that makes it possible to compare two heterogeneous theories. In this sense, it functions as a metalanguage, making their articulation possible.

2.2 Defining the Set of Systemic Concepts

In this study, systems thinking is employed as an analytical metalanguage, enabling the comparison of heterogeneous theories through their underlying structuring mechanisms. It provides a set of fundamental concepts (such as system, environment, structure, function, flow, feedback, regulation, emergence, …) able to describe internal dynamics and organizational properties of the theories under investigation.

To ensure analytical rigor and cross-domain comparability, the selection of concepts follows explicit criteria. Universality was prioritized, retaining notions shared across major systemic traditions and sufficiently abstract for cross-domain comparison. Functional representativity guided the construction of a corpus covering the three main dimensions of systemic organization:

1. Definition and structure: concepts describing the composition, organization, and boundaries of a system (system, environment, structure, function, hierarchy, openness, closure).
2. Internal dynamics and flows: concepts capturing processes and interactions within the system (flow, feedback, regulation, adaptability, etc.).
3. Emergent properties: concepts highlighting the system's emergent effects and behaviors (emergence, self-organization, wholeness).

Cognitive and epistemic relevance favored notions capable of modeling reasoning and learning processes rather than merely physical systems. Historiographical convergence ensured that the selected terms belong to a shared lexicon within classical systems theory, while analytical sufficiency justified the focus on concepts bridging internalist and externalist perspectives.

Together, these criteria yield a coherent and operational framework for cross-theoretical comparison presented in Table 2. The reduced set of concepts reflects a methodological choice to balance representativity and clarity rather than exhaustiveness. It presents transversal vocabulary particularly suited to Conversation Theory and Architecturology, which both model dynamic processes rather than fixed objects. Systems thinking thus provides a privileged framework for analyzing these theories as conceptual systems, revealing their structuring mechanisms beyond disciplinary boundaries.

2.3 Analytical Procedures

The analysis relies on Table 2, which confronts each systemic concept with its use in both theories: Conversation Theory and Architecturology. The procedure unfolds in three steps:

1. Concept selection and identification: A core set of systemic notions is defined and categorized (structure/dynamics/emergence) according to the criteria outlined above. These concepts appear in the first column of Table 2.
2. Concept coding in both theories: Each concept is examined within Conversation Theory and Architecturology. The systemic mechanisms structuring each theory are identified in the second and third columns of Table 2. Coding relies on textual analysis of primary sources, indicating whether each concept is used explicitly, partially, or implicitly (present, partially applied, or absent).
3. Comparison and mapping: For each concept, similarities, differences, correspondences, and non-correspondences are identified. The results are then interpreted to reveal convergences and divergences, as well as structural patterns and semantic relationships among concepts.

This clarifies how each theory mobilizes systemic mechanisms and whether shared organizational logics emerge at the model level.

3 Results: Systemic Concepts Applied to Conversation Theory and Architecturology

Table 2. Systemic concepts applied to Conversation Theory and Architecturology

Systemic concepts	Conversation Theory	Architecturology
Definition and structuring of a system A **system** is a network of **interacting elements**, organized to achieve specific **functions**, and embedded within an **environment**. It may be **open** (exchanging energy, matter, or information) or **closed**, tending toward equilibrium or entropy. Defined by their **structure** (elements, boundaries, subsystems) and **functional properties** (exchanges, flows and transformations). They exhibit multiple **organization levels**,	**Elements**: participants (human or artificial), languages, concepts. **Interactions**: conversational rules that transform representations. **Finality (Aims)**: (1) achieve shared understanding and operational agreement; (2) reflexively describe the processes of conversation and learning. **Equifinality**: different participants can reach agreement via distinct paths, producing pragmatic equivalence for coordinated action. **Environment**: source of contextual inputs and triggers shaping system dynamics. **Openness/closure**: the system is open in terms of exchange with the environment but organizationally closed, as transformations occur within internal conceptual meshes (entailment meshes) **Structural organization**: entities (participants, representations, concepts), relations (verbal, graphical, or symbolic exchanges), and levels of language (object, meta, strategy) integrated into entailment meshes. Cognitive and operational **functions**: learning, stabilizing, and demonstrating operational agreement. **Levels of organization**: (1) Hierarchies of language (natural language, object language, metalanguage) (2) Interaction loops (elementary, metacognitive, global) (3) Conceptual networks (entailment meshes integrated into an overarching entailment structure) (4) Learning plans: knowledge of what and knowledge of how (5) Propagation of	**Elements**: conceptual and operational elements (models, scales, measures, operators, operands, referencing, partitioning, dimensioning). **Interactions**: dynamic organization producing successive transformations (M1 → M2). **Finality (Aims)**: (1) make the internal logic of design explicit; (2) scientifically formalize architectural reasoning. **Equifinality**: different scales or projects can reach the same final state via analogous operations. **Environment and Openness/closure**: continuous exchange with a dual environment (1) practical field (site, uses, constraints, cultural values) providing external references; (2) scientific field (theoretical knowledge). Subsystems interact with elements from both theoretical and real spaces, while organizational closure remains relative (theoretical autonomy vs. operational dependence on context). **Structural organization**: networks of fundamental concepts (models, scales, measures, relevance, coupling) and cognitive operations (referencing, dimensioning). Cognitive **functions**: analyze, transform, and justify design decisions. **Levels of organization**: (1) Hierarchical reasoning (fundamental concepts guide cognitive operations, which are applied to concrete choices) (2) Branching process (projects unfold exploratorily from an initial model, with each scale and operation enriching reasoning) (3) Interaction loops among operations (referencing, partitioning, dimensioning) (4) Nested cognitive and real spaces (the architect navigates

(*continued*)

Table 2. (*continued*)

including hierarchies, and feedback loops that regulate their behavior.	interactions: each interaction modifies local representations, which then propagate globally across the system	between conceptual thought and material constraints) (5) Dual structure: logical (operations) and cognitive (representations)
Dynamics and Flows **Flows** and **transformations** refer to the circulation of information, matter, or energy within a system and between the system and its environment. **Feedback loops** relay the effects of system actions, enabling **regulation** and maintaining dynamic equilibrium (**homeostasis**). These dynamics operate across multiple **temporal scales** and rely on **variety** and **adaptability** to respond to perturbations and limit entropy.	**Information flows**: transfer between participants and concepts, enabling exchanges, reformulations, and validations. **Transformations**: cumulative evolution of knowledge produced by interactions among elements. Multiscale **feedback loops**: (1) Elementary loops (immediate coordination and adjustment of knowledge during interactions) (2) Metacognitive loops (regulation of the learning process, self-regulation, and structured progression) (3) Global loops (long-term guidance of the conceptual mesh, ensuring **adaptive regulation** and system **resilience**) **Homeostasis**: an adaptive equilibrium that maintains coherence of the conceptual mesh while integrating new knowledge. **Adaptability**: each participant is a self-adaptive system, adjusting representations and learning strategies based on feedback. **Variety**: diversity of hypotheses, strategies, and actors (human, artificial, institutional) augments the system's potential **Interaction of adaptability and variety**: dynamic adjustment of the conceptual mesh, fostering robustness and emergent knowledge. **Temporal** scales: short-term dynamics (elementary interactions) and long-term dynamics (metacognitive and global loops). **Interaction and structuring**: flows and feedback structure the conceptual mesh, facilitating coordination and collective learning.	**Flows and transformations**: transfer between conceptual representations (cognitive space) and operational decisions applied to projected objects. Each transformation shifts the model from state M1 to M2, linking the abstract project to its concrete materialization. **Feedback loops (between model, scales, and measures)**: adjust choices and operations by integrating external constraints (site, uses, techniques) and internal information (referencing, relevance, partitioning), ensuring coherence and continuity of the project (**regulation**). **Homeostasis**: dynamic equilibrium between internal and external constraints, maintaining conceptual stability without blocking evolution. **Adaptability**: continuous adjustment of operational choices to contextual variations while preserving coherence and invariants. **Variety**: each operation generates new alternatives, opening a spectrum of potential solutions that enrich the design process. **Temporal** scales: reasoning unfolds over long-term progression through successive adjustments rather than linear deductions. **Interaction and structuring**: flows and feedback organize adaptability and variety, supporting creativity, flexibility, and conceptual continuity.

(*continued*)

Table 2. (*continued*)

Emergence and Evolution **Emergence** arises from local interactions that give rise to **global patterns** not reducible to individual components. **Self-organization** and **autopoiesis** sustain the system's structure and identity, while **recursivity** and **self-referential feedback loops** drive ongoing adaptation and transformation. The principle of **wholeness** asserts that the system possesses qualities that exceed the sum of its constituent parts.	**Self-organization**: long, multilevel feedback loops, supported by teachback, continuously adapt and optimize the conceptual mesh. **Autopoiesis**: the conversational system produces and maintains itself through its own processes, with external signals acting only as perturbations or triggers. Structural coupling between participants ensures a self-organized, self-maintained mesh. **Recursive and self-referential loops**: each interaction (question, answer, reformulation, teachback) feeds a circular cycle in which the conversation reflects on and reorganizes itself, consolidating knowledge: $Concept_0$ (Question) → $Result_1$ → $Result_1$ (Reformulation) → $Result_2$ (Teachback) → $Result_3$ (New interactions) **Emergence**: individual interactions generate collective knowledge and conceptual structures that exceed isolated contributions: (1) Elementary emergence: creation of new connections (2) Metacognitive emergence: learning strategies and shared validation (3) Global emergence: coherent and evolving conceptual mesh (4) Reflective emergence: stabilization of reflexive patterns **Wholeness**: the conceptual mesh forms an integrated system in which each interaction influences the whole. Feedback loops integrate individual adjustments, producing coherence and adaptive structuring. The system generates emergent properties (shared understanding, new knowledge) irreducible to isolated components.	**Self-organization**: the design project emerges without a strict master plan. Local interactions between models, scales, and operations produce globally coherent, self-regulated structures. **Autopoiesis**: at the operational modeling level, architectural reasoning does not generate its fundamental concepts ex nihilo but maintains and complexifies them through the cognitive activity of the designer, who iteratively adjusts and transforms models. Reasoning is self-referential and reflexive, expressing autopoiesis limited by maintenance, evolution, and self-organization. **Recursive and self-referential loops**: each model transformation becomes the operand of a subsequent operation, generating an iterative chain: $Operator_1(Operand_1)$ → $Result_1$ → $Operator_2(Result_1)$ → $Result_2$ … Reasoning continuously monitors and transforms itself, with each intermediate result feeding the next cycle. This ensures coherence, adaptation, and evolution within a processual **temporal framework**. **Emergence**: internal and external adjustments (intuition, constraints, reformulations) transform models, generating multiple levels of emergence: (1) Local: variations and alternatives (2) Structural: patterns and invariants (3) Global: coherence, adaptability, new structures (4) Practical: tangible forms and devices **Wholeness**: cognitive concepts and operations form a dynamic network. Feedback loops integrate successive adjustments, so the whole exceeds the sum of its parts, emerging from interactions between elements.

The comparison of Conversation Theory and Architecturology reveals convergences and divergences across the three systemic categories used in Table 2.

Structurally, both theories model conceptual systems composed of interacting units; however, Conversation Theory integrates external participants and media (externalist), whereas Architecturology emphasizes the designer's internal operations (internalist).

Dynamically, both rely on feedback, recursivity, and adaptive regulation, yet their temporalities differ: Conversation Theory mobilizes rapid conversational loops within distributed interactions (externalist dynamics), while Architecturology unfolds through cumulative adjustments within a situated reasoning process (internalist dynamics).

Emergence appears in both models through higher-level properties (shared understanding in Pask; structured projectual reasoning in Boudon). These emergent effects reflect distributed co-construction in Conversation Theory (external emergence) and progressive conceptual organization in Architecturology (internal emergence).

Overall, the results indicate that the three systemic categories do not merely oppose internalism and externalism; rather, they illustrate how both theories mobilize similar systemic concepts while orienting them differently: structural configurations determine whether the locus of cognition is internal or interactional; dynamic mechanisms shape how feedback and recursivity operate; and emergent effects arise either from distributed exchanges or from progressive internal structuring.

4 Discussion and Conclusions

4.1 Dialogue Between Internalism and Externalism: A System-Based Analysis of Two Conceptual Approaches

Treating both theories as conceptual systems extends Pask's intuition and validates our main hypothesis: systems thinking can operate as a metalanguage connecting heterogeneous theories through shared organizational logics. It not only describes but operationalizes cross-theoretical comparison, confirming its methodological value as a framework for analyzing and mapping conceptual systems.

Confronting Conversation Theory and Architecturology at the model level reveals that theoretical models constitute an effective locus for transdisciplinary dialogue. The comparison highlights shared systemic invariants and productive divergences, reflecting similar dynamic structures modulated by distinct orientations.

Both theories model conceptual systems: Conversation Theory articulates internal elements (representations) and external ones (participants, media), while Architecturology formalizes the internal operations of the designer (concepts, scales, measures). In both, interactions produce transformations (shared learning for Pask, project development for Boudon) within systems open to their environment. Yet, Conversation Theory remains organizationally closed (transformations occur within internal meshes), whereas the architect must negotiate and integrate external constraints (context, program, norms). This tension between openness and closure defines partially constrained systemic openness, pursuing different but coherent goals: shared agreement for Conversation Theory, project relevance for Architecturology.

Regarding system dynamics, flows concern information, symbols, or operations. Both systems rely on feedback loops and adaptive homeostasis: Conversation Theory involves rapid conversational loops (immediate coordination), slower metacognitive loops (self-regulation), and long-term structuring loops; Architecturology articulates longer temporalities through successive adjustments (stabilization, inter-scale maturation). Variety, adaptability, and recursivity regulate both systems, allowing them to respond to perturbations.

Emergence manifests in Pask's conversational mesh as well as in Boudon's combination of models and scales. Autopoiesis is explicit in Conversation Theory, implicit yet present in Architecturology through recursive design cycles, both expressing a systemic logic where the whole exceeds the sum of its parts.

Divergences concern temporality (multi-scale feedback in Pask vs. cumulative progression in Boudon), actors (collective vs. situated individual), and cognitive orientation (externalist vs. internalist). Yet, these contrasts reveal complementary modes of system behavior: autonomous and self-organizing in Conversation Theory; contextual and adaptive in Architecturology. This suggests that feedback, adaptation, and openness act as scale-invariant mechanisms across distributed and situated cognition. Temporality thus emerges as a structural variable, organizing reasoning from rapid conversational exchanges to cumulative projectual maturation. Ultimately, these contrasts unveil a symmetry between internal and external cognition, whose coupling can be modeled through systemic invariants.

Used reflexively, system thinking extends from modeling phenomena to modeling theories themselves, revealing how they self-organize, adapt, and evolve. This demonstrates that theories, composed of concepts, relations, and feedback structures, function as dynamic systems. In this sense, systems thinking operates as a metatheory of conceptual modeling, capable of analyzing how disciplines construct and regulate their own cognitive structures. It accommodates the coexistence of internalist and externalist approaches without reducing them and highlights continuities and discontinuities between fields as diverse as cybernetics, pedagogy, architecture, and design, reinforcing its status as a transdisciplinary paradigm.

For Conversation Theory, the study clarifies the mobilized systemic concepts structuring learning and communication. Its externalist nature and distributed cognitive model are confirmed: its strength lies in analyzing interactional dynamics, though it remains less operational for formalizing internal cognitive operations. Identifying shared systemic invariants with another theory strengthens its internal coherence and situates it within a broader epistemological framework.

For Architecturology, the comparison shows that, despite its internalist focus, it partially integrates external interactions (contextual and social constraints). Although Boudon never claimed a systemic stance, the implicit dynamic structures of Architecturology constitute an 'architecturology of architecturology', reinforcing its scientific legitimacy and positioning it within systemic and cognitive theory networks. This perspective enhances visibility and legitimacy within the scientific domain beyond architecture. The juxtaposition with Conversation Theory and systems thinking clarifies that Architecturology does not produce architectural projects directly, but rather models the

reasoning underlying them, clarifying its status and dispelling common misunderstandings. It also opens pathways for pedagogical, analytical, and computational applications already initiated by successors (Guéna, Lecourtois, etc.).

4.2 Scope, Perspectives, and Limitations

This study proposed a cross-reading of Conversation Theory and Architecturology through the lens of systems concepts. By defining a common level of analysis (model level) we compared these theories as conceptual systems, highlighting both significant convergences and irreducible divergences. This approach goes beyond a simple disciplinary juxtaposition: it offers a methodological framework in which systems thinking functions as a metalanguage connecting heterogeneous theoretical models.

Although system thinking encompasses a broader conceptual corpus, this study deliberately focused on a reduced set of notions describing internal dynamics and structuring properties, for reasons of clarity and operational feasibility. The comparison was limited to the model level, without extending to theoretical, methodological, or applied dimensions, and considered the theories in their foundational forms: Conversation Theory prior to its extension into the Interactions of Actors Theory [3], and Architecturology before its later developments by Guéna, Lecourtois, and others.

These limitations open several perspectives for further research. Epistemologically, the analysis could be extended to paradigmatic and methodological levels to better articulate the relations between metatheory, theory, and practice. Situating the frameworks within their 1960s–1970s intellectual context (cybernetics, structuralism, cognitive sciences, …) would further illuminate contextual convergences and theoretical lineages. Broadening the comparison to other models of design reasoning could also support a meta-modeling of design theory or of Architecturology itself.

The epistemological implication of this convergence is that reasoning, whether dialogical or projectual, can be modeled as a self-regulating system integrating internal and external dimensions of cognition. Systemic metatheory redefines methodology itself: rather than studying design or learning as linear processes, it models them as adaptive, recursive, and context-dependent dynamics. From this perspective, design research gains a framework for analyzing reasoning as an evolving system of operations and representations; pedagogy benefits from reflexive learning environments grounded in feedback and co-construction; and artificial intelligence can draw on these systemic principles to design architectures that simulate not only reasoning outcomes but the adaptive processes through which they emerge. In this sense, the systemic approach offers a methodological foundation for metamodeling in architecture and beyond. Graphic and computational formalizations could make explicit how Conversation Theory and Architecturology organize reasoning, while enabling transpositions into digital, pedagogical, or cognitive modeling tools. The systemic transcription of both frameworks opens perspectives for computational modeling, particularly within symbolic and distributed artificial intelligence. This represents a concrete direction for future work, as implementing such computational or graphic models would allow testing and operationalizing the systemic metatheory in practice. Recent advances in hybrid, abductive, and explainable AI illustrate a similar epistemic shift, from static knowledge formalization toward adaptive, inferential, and self-regulating models of reasoning. Within this

evolving context, the systemic metatheory proposed here provides a conceptual framework for understanding and designing such systems, emphasizing feedback, recursion, and emergence as core mechanisms of intelligent and reflexive behavior. By formalizing how design-based knowledge systems organize reasoning, it contributes to research on transparent and context-aware AI.

Ultimately, this study contributes to a broader epistemological reflection on systemics as a metatheory of modeling, one that not only bridges distant theoretical domains such as cybernetics, pedagogy, architecture, and AI, but also helps to formalize how knowledge systems evolve, communicate, and self-organize across disciplines.

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