

The IDEA Design Scaffold: A Developmental Framework for Functional Ideation in Systemic Design

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ABSTRACT

Functional ideation in systemic design unfolds within sociotechnical and sociocultural environments where goals, constraints, and evaluative criteria evolve across multiple levels of organization. Creativity research explains important aspects of novelty, variation, recombination, and selective retention, but it often treats novelty as emerging within a relatively stable representational space or a single level of abstraction. Systemic design scholarship, in turn, has developed strong approaches for framing complexity, mapping relations, organizing participation, and coordinating action, but it less often specifies how designers navigate between systemic levels, address challenges at different levels of abstraction, and construct intervention candidates while the task environment is still being differentiated. This paper responds by proposing a naturalistic framework of ideation within the Interactivist–Constructivist paradigm, with the IDEA Design Scaffold as its methodological architecture for systemic design. The central claim is that functional ideation under systemic complexity must be understood as a self-directed developmental process: intervention opportunities become novel and appro-

priate as designers navigate across levels of complexity through anticipatory exploration, partial stabilization, reflective reorganization, and rebuilding of missing supports. IDEAS operationalizes this account by linking Systemic Breakdown and Systemic Integration through the Iterative Innovation Cycle, enabling systemic goals, design challenges, and intervention candidates to be progressively coordinated without reducing ideation to a fixed procedure. The payoff is both theoretical and methodological: the paper explains why creative development in systemic design requires movement across levels of complexity, and provides an architecture for supporting, studying, and refining that movement in systemic design practice.

KEYWORDS:

Systemic Design; Ideation; Sociotechnical Complex Systems; Creative Thinking; Recursive Constructivism; Self-Scaffolding

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1. INTRODUCTION: THE EPISTEMOLOGICAL CHALLENGE OF IDEATION IN COMPLEX SYSTEMS

Systemic design has developed strong ways to frame complexity, map interdependencies, support participation, and coordinate intervention work. Yet the development of intervention candidates within such complexity still requires clearer specification. Functional ideation¹ in systemic design does not unfold within bounded task environments where goals, constraints, and evaluative demands are stable enough to be treated as inputs to idea generation. It unfolds within sociotechnical and sociocultural systems whose actors, infrastructures, and environmental conditions interact across multiple levels of organization. In such settings, the difficulty is not only to understand complexity, but to construct intervention candidates while the task environment is still being differentiated and while the conditions of viability are still being learned (Bauer & Herder, 2009; Capra & Luisi, 2014; Meadows, 2008).

Design challenges² in these contexts are wicked in nature, since they are ill-defined, open-ended, and cannot be fully specified in advance (Farrell & Hooker, 2013; Head, 2022; Rittel & Weber, 1973; Waddock et al., 2015). Moreover, the knowledge required to address them cannot be derived from combinatoric relations³ among predefined elements (Gabora & Steel, 2022). In systemic design, the design challenge is progressively specified through engagement with the system rather than fully determined in advance. As systemic goals are reformulated into evaluable targets for change, feedback from intervention trials clarifies what must count as success, and this clarification can in turn reshape the challenge framing itself (Waddock et al., 2015).

Functional ideation in such contexts is therefore not oriented toward endpoints or finalized outcomes, but toward the developmental construction of interventions that can remain coherent as uncertainty, interdependencies, and boundaries shift during engagement. This developmental orientation is required because systemic design does not only ask whether an emerging intervention can be improved within the current framing; it asks whether the ideation trajectory can open a new direction for change in the task environment (Banathy, 1996; Jackson, 2019; Meadows, 2008; Norman & Stappers, 2015). Such novelty requires a creative exploration trajectory that can be progressively reorganized as broader systemic relations become relevant, rather than merely

1 Functional ideation builds on the concept of functional creativity, which defines creativity as both novel and useful (Charyton et al., 2008; Cropley & Cropley, 2005; Daly et al., 2014). In design, this means valuing innovation that addresses functional demands or contextual constraints, rather than expressive or artistic goals.

2 We use the term '*design challenges*' rather than '*design goals*' to emphasize their constructed and developmental nature. Unlike systemic goals, which regulate existing system behavior, design challenges are created by the designer to reorganize this regulatory structure in response to systemic complexity.

3 Structured ideation methods such as TRIZ often work by resolving contradictions among predefined design parameters through generalized inventive principles, as illustrated in Navas's discussion of contradiction resolution and ideality in complex technical systems (Navas, 2017). This supports recombination within an already structured design space. It can be effective in complicated technical contexts, but it does not by itself explain how systemic goals, challenge framings, and intervention candidates are reorganized through multi-level learning under systemic complexity.

refined within the assumptions from which it first emerged. In this sense, development does not mean ordinary progress or iterative refinement within the current organization; it refers to a constructive trajectory in which prior constructions become supports for higher-level organization, while creativity names the kind of purposeful transformation through which a body of knowledge is significantly reorganized. The explanatory requirement is therefore to account for ideation as a developmental process in which emerging intervention candidates become supports for higher-level reorganization, rather than only as the generation of alternatives within an already specified challenge (Bickhard, 2006; Feldman, 1989, 1999).

Prevailing models in creativity research conceptualize creative thinking as idea generation and variation within a relatively stable representational space. Confluence and componential accounts emphasize the interaction of abilities, motivation, and contextual conditions that support creativity, and systems perspectives highlight social and cultural dynamics, yet they typically treat development as the refinement of strategies or the recombination of existing knowledge structures rather than as the reorganization of representational spaces under feedback (see Amabile & Pratt, 2016; Csikszentmihályi & Wolfe, 2014; Sternberg, 2003). Related accounts that focus on divergent thinking and variation similarly retain the assumption that creativity operates within a predefined space of alternatives, whether through fluency or probabilistic search (see Runco, 2010; Simonton, 2011). More mechanism-specific models make this assumption explicit. Goel's modular decomposition theory, Martindale's associative activation model, and Simonton's probabilistic reformulation of Campbell's Blind Variation and Selective Retention all frame ideation as search among predefined alternatives (see Goel, 1995; Martindale, 1999; Simonton, 2011). These models remain valuable for explaining enabling conditions, generative variation, associative activation, recombination, and selective retention. For the present argument, however, the key limitation is that novelty is largely treated as emerging within a single level of abstraction, where creative work proceeds by varying, combining, or selecting among already available elements. They therefore do not specify how a creative exploration trajectory can move beyond refinement within the current representational level when the kind of transformation required in systemic design demands the construction of a higher level of organization.

Systemic design scholarship addresses the complementary side of this issue. It has clarified why design must engage complex sociotechnical environments and has developed strong approaches for framing uncertainty, mapping relations, organizing participation, clarifying boundaries, and coordinating action (see Banathy, 1996; Buchanan, 2019; Checkland & Poulter, 2020; Jones & Kijima, 2018; Nelson & Stolterman, 2012; Norman & Stappers, 2015; Sevaldson, 2022). These contributions are indispensable because ideation in systemic contexts cannot be separated from the wider organization of the task environment. However, their primary explanatory emphasis tends to be placed on how complexity is framed, represented, negotiated, or acted upon, rather than on how intervention candidates develop as creative constructions within that complexity. The missing specification is therefore not systemic orientation itself, but the developmental structure of ideation: how designers navigate between systemic levels, how they address challenges at different

levels of abstraction, and how intervention candidates are generated, stabilized, revised, and reorganized as these cross-level relations become relevant for intervention.

For this reason, the paper turns to a cognition paradigm developed for complex interactive systems, namely the Interactivist–Constructivist⁴ (I–C). The I–C paradigm is relevant because it treats cognition as interactive knowing: an anticipatory organization of activity oriented toward successful engagement with the task environment. Knowing is therefore not treated as the manipulation of fixed internal representations, but as a constructive process through which anticipations are tested, differentiated, and reorganized in interaction. This is important for systemic ideation because intervention possibilities do not appear as predefined options, and higher-level novelty cannot be generated only by refining candidates within the current representational level. The I–C paradigm provides the mechanism vocabulary for explaining how a current construction can become available for higher-level organization: anticipatory trials differentiate possible directions of action, nearby points of stability make partial constructions available for further reflection, reflective abstraction allows properties implicit in one level of organization to become explicit at a higher level, and self-scaffolding supports this movement when full coherence is not yet possible. Methodologically, the IDEA Design Scaffold⁵ (IDEAS) operationalizes this account by making systemic goal hierarchies explicit, translating selected goal relations into design challenges, and supporting the development of intervention candidates through the Iterative Innovation Cycle.

The paper proceeds in two steps. Section 2 develops the theoretical account by showing how anticipative learning, self-scaffolding, nearby points of stability, reflective abstraction, and hierarchical organization support creative development under systemic complexity. Section 3 operationalizes this account through the Scaffold: Systemic Breakdown, the translation of systemic goal hierarchies into design challenges, and Systemic Integration through the Iterative Innovation Cycle.

4 The I–C paradigm is used here as a naturalistic and process-oriented framework for cognition, learning, and development. Its epistemological orientation differs from correspondence or encoding-based accounts of mind: cognition is not explained as the internal representation of a pre-given world, but as an emergent organization of autonomous activity through which living systems construct conditions for successful interaction. This orientation develops from work on biological organization, action selection, autonomous agency, and constructivist accounts of knowing, and is compatible with broader process-based approaches to cognition while retaining its own account of representation, normativity, and development (Arnellos et al., 2008; Bickhard, 1988, 2009, 2024; R. L. Campbell & Bickhard, 1986; Christensen & Hooker, 1999; Collier & Hooker, 1999; Hooker, 2011). In the present paper, this epistemological grounding supports a naturalistic account of ideation in which creative thinking is explained through emergent organization and developmental transformation rather than through the recombination of fixed representational contents.

5 The acronym IDEAS (*Integrative Design for Evolving Action Systems*) informs the name IDEA Design Scaffold. The terms “IDEAS” and the “Scaffold” are used interchangeably throughout the text. The approach is described as transdisciplinary insofar as it is organized around complex sociotechnical challenges and works across, between, and beyond disciplinary framings through integrative, co-produced knowledge that can guide action in context.

2. A DEVELOPMENTAL ACCOUNT OF IDEATION UNDER SYSTEMIC COMPLEXITY

Systemic ideation requires a developmental account of how intervention representations can be constructed, stabilized, and reorganized when both the representation and what counts as viable can change through engagement. This section develops that account by drawing on the I–C paradigm of cognition for complex interactive systems. Creativity is understood as a particularly strong instance of development in which a personal reorganization yields a significant change in the external form of a domain (Feldman, 1989, 1999). Under complexity, such developmental transformations take the form of emergent constructs, namely ideas that must remain workable as conditions evolve (Head, 2022; Jackson, 2019; Jones, 2014; Waddock et al., 2015). In creativity terms, this means that novelty becomes relevant to functional ideation only when the emerging construct can also sustain appropriateness or functionality within the changing task environment (Hennessey & Amabile, 2010; Runco, 2022; Sternberg et al., 1999).

The I–C paradigm is adopted to ground IDEAS in a naturalistic explanatory framework of creative thinking under systemic complexity. The central commitment is that interactive knowing becomes developmental when learning, understood as the constructive modification of knowing, can no longer resolve uncertainty within the current level of organization. A key requirement, therefore, is that the higher-order cognitive system can detect and respond to conditions of ill-defined or failing interaction. R.L. Campbell and Bickhard (1986) propose that learning depends on differentiating such conditions of process uncertainty in the knowing system and feeding them back into ongoing activity, allowing uncertainty to function as an internal cue for the anticipatory reorganization of ongoing activity. This makes error and correction constitutive of development rather than exceptional, and it explains why exploration in complex settings is expected to proceed through branching trials whose viability becomes intelligible only through engagement. This is the basis for the SDAL account developed below: anticipative learning trials allow the system to explore possible directions of action prospectively, before full commitment, while remaining open to revision as uncertainty becomes more differentiated. When such differentiated uncertainty cannot be resolved by further adjustment within the current organization, the current construction must become available as an object of higher-level reflection. A further developmental constraint is that reorganization proceeds through sequential levels of reflection: construction cannot skip levels, and higher-level reorganization must be built through reflective abstraction, understood here as the process through which properties implicit in one level of knowing become available for explicit organization at the next level (R.L. Campbell & Bickhard, 1986). Because higher-level organization cannot be reached by skipping the intermediate constructions that make it possible, development requires temporary supports that keep partially coherent constructions available for further reorganization. This is the role of self-scaffolding, which is developed later in this section. This developmental constraint is directly relevant to systemic ideation because maintaining viability

in multi-level complexity often requires reorganizing not only candidate constructions but also the goals and evaluative criteria by which they are guided (R.L. Campbell & Bickhard, 1986; Head, 2022; Jackson, 2019). On the knowing-level approach, evaluative criteria can be developmentally organized across levels of abstraction, thereby guiding exploration by reorganizing what counts as success as learning progresses (R. L. Campbell & Bickhard, 1986). These commitments provide the explanatory basis on which SDAL and scaffolding mechanisms are developed in the remainder of Section 2, and on which the methodological architecture of IDEA Design Scaffold (IDEAS) in Section 3 is motivated.

A developmental account is therefore needed to explain how ideation can remain viable when both representations and their evaluative criteria can change through engagement. Such an account must also explain how constructive activity remains organized while its own conditions of evaluation continue to evolve, rather than assuming fixed goals or stable criteria from the outset. The remainder of this section specifies the functional roles within that single constructivist process. It starts with self-directedness as the capacity for continued revisability of the constructive process itself, and then shows how anticipative learning and scaffolding sustain development when coherence is partial and demands conflict (Bickhard, 2024).

A mechanism account is methodologically valuable because it links explanation to design guidance: it specifies which functional roles must be achieved for ideation to remain productive as conditions evolve, and it therefore supplies principled criteria for diagnosing breakdowns and for selecting targeted corrective moves. This makes methodology cumulative rather than artisanal: refinements in the explanatory account translate into refinements in what a methodology must enable, without presupposing that any single technique is privileged. IDEAS in Section 3 is introduced in this spirit, as an architectural organization that supports methodological pluralism while keeping method selection accountable to the developmental requirements identified in Section 2.

2.1. Self-directedness as the condition for open-ended ideation

Within the I–C paradigm, self-directedness is treated as a foundational property of higher-order cognitive systems. It is not approached merely as a motivational trait for creative thinking (Amabile & Pratt, 2016; Csikszentmihályi, 1988), but refers to the system's higher-order capacity to revise its own activity in response to interaction, using its own resources. Self-directedness can therefore be understood as an integrative capacity for flexible, proactive goal-directed activity, in which anticipation, evaluation, and action modulation improve the coordination between actions, opportunities, and requirements in context-sensitive ways, including during ideation (Christensen, 2004; Christensen & Hooker, 2000). For self-directed thinkers, interaction challenges remain open in the relevant sense: neither the decisive factors nor the means of influencing them are fully known at the outset, and interventions do not terminate in a final state. Self-directedness therefore supports sustained constructive revisability in task environments that are dynamically changing and complex.

As we further explain next, this orientation is developmental rather than selection-from-options. Self-directedness enables ideation to proceed by transforming the structure of interactive challenges and the constraints that shape them, while also revising what is treated as adequate performance as those constraints become clearer through engagement. In this sense, ideation is a higher-order activity that can reorganize its evaluative criteria while generating representations of opportunities for intervention⁶ that are both novel and viable. This is the point of contact between higher-order ideation and the self-improvement loop: revising an idea is not enough if the evaluative criteria that guide revision remain fixed or mis-specified for the unfolding situation. The payoff is that self-directedness enables a self-improvement loop in which anticipatory evaluation keeps exploratory construction open to revision by registering mismatch, incompatibility, or unmet conditions, rather than stabilizing prematurely (Bickhard, 2024). In this loop, what can change is not only the content of the construction but also which evaluative criteria are treated as governing at the current stage, including what counts as working, coherent, or worth pursuing. Crucially, the target of improvement is not only the idea but the thinker's constructive process itself: in recursive constructivism, prior constructions are reorganized, and in meta-recursive constructivism the processes that generate and revise those constructions are also revisable, enabling learning-to-learn within ideation (Bickhard, 2019; R.L. Campbell & Bickhard, 1992). In creativity terms, this shift in evaluative criteria supports movement toward more demanding and publicly contestable standards of what the work must satisfy (Beghetto & Kaufman, 2007).

Without self-directedness, ideation cannot remain open-ended because there is no internal basis for revising ongoing construction when interaction reveals inadequacy. The next section specifies the two mechanisms through which this self-directed revisability is realized in ideation. These are anticipative learning trials and scaffolding strategies that keep construction productive as demands evolve.

2.2. Self-directed developmental change in ideation

2.2.1. *Anticipative learning as prospective exploration in systemic ideation*

If creative exploration is understood as knowledge construction that is dynamically revised as engagement unfolds, then ideation cannot be adequately characterized as a one-shot proposal followed by choosing among fixed alternatives, as in probabilistic search-and-selection accounts of creative ideation (see e.g., Simonton, 2011). In a naturalized account, what counts as a workable construction is not available in advance as a fixed set of options. It is learned through ongoing trials in which variation generates candidate directions and selective retention preserves only those that continue to work as constraints emerge, while unsuccessful directions are discarded or reorganized

⁶ Throughout Section 2, '*representations of opportunities for intervention*' refers to the organized and revisable content constructed in ideation. When the focus is on earlier, cue-like content that points toward possible action before it is fully organized, the text refers instead to '*anticipations/indications of intervention potentiality*' in the I-C sense. Section 3 introduces '*systemic affordances (SysAf)*' as a method-facing operationalization of these intervention-relevant indications within IDEAS.

(Bickhard & Campbell, 2003). In the I–C paradigm, learning is not “collecting facts about the task environment” in the ordinary sense. It is the internal constructive reorganization of the thinker’s anticipatory organization so that interaction can succeed and the environment can be differentiated in usable ways. That differentiation is not separate from learning but one of its core achievements. Accordingly, what appears as “knowing the task environment’s organization” is better framed as developing usable differentiations and anticipations that keep further interaction viable. In this framing, learning concerns the ongoing construction and revision of engagement, whereas development concerns how those constructions accumulate and reorganize across time as a trajectory with dependencies over time (Bickhard, 2006). On that basis, learning and development proceed through anticipatory trials and prospective revision under expected error, so exploration can remain organized as a revisable trajectory rather than collapsing into disconnected attempts.

This is especially important in systemic design, where wicked challenges can shift what counts as a promising direction for intervention while ideation is underway, and where feedback may be delayed, partial, or ambiguous (Jones, 2014). In such conditions, relying on reactive correction after action is often insufficient, because commitments can be costly to reverse and can constrain subsequent possibilities (Rittel & Webber, 1973). This is consistent with creativity accounts that treat creative work as sustained exploration with iterative refinement rather than single-pass production (Green et al., 2024; Sternberg, 2003).

Within the I–C paradigm, this prospective organization of learning and development is specified through Self-Directed Anticipative Learning (SDAL⁷; see Christensen, 2004; Farrell & Hooker, 2007b, 2007a). SDAL frames ideation as an anticipative learning trajectory in which provisional framings and candidate constructions are explored through anticipatory trials and reorganized as exploration proceeds. In this tradition, SDAL is developed as a general process account of deep problem-solving and scientific development, and is articulated as the basis of a problem-solving paradigm with application beyond science to cognate domains, including design (see Christensen & Hooker, 2000; Hooker, 2018; Xenakis & Arnellos, 2025). Progressive anticipative modulation preserves continuity across iterations while enabling revision as constraints and feedback emerge. Figure 1 summarizes this logic by showing how successive anticipatory trials can yield progressively more viable constructions within a single level of engagement, without presupposing that the initial framing is already adequate.

7 SDAL is used here as a developmentally grounded process account within the I–C paradigm, drawing on its commitment to meta-recursive learning: not only are particular constructions revisable, but the learner’s own construction processes can be reorganized over time (“learning to learn”; see Allen & Bickhard, 2022; Bickhard, 1978, 1999; R. L. Campbell & Bickhard, 1992). SDAL draws on these commitments by providing a process vocabulary for open-ended problem solving in complex interactive systems (Christensen & Hooker, 1999; Hooker, 1994, 2018). Related SRL/SDL and scaffolding literatures are used to support the general claim that complex tasks require monitoring and demand-management, while the mechanism claims about anticipatory revision and developmental reorganization are developed within the I–C/SDAL tradition. Here, scaffolding is treated as self-scaffolding: self-directed management of evaluative and representational demands under partial coherence (Bickhard, 2005, 2007).

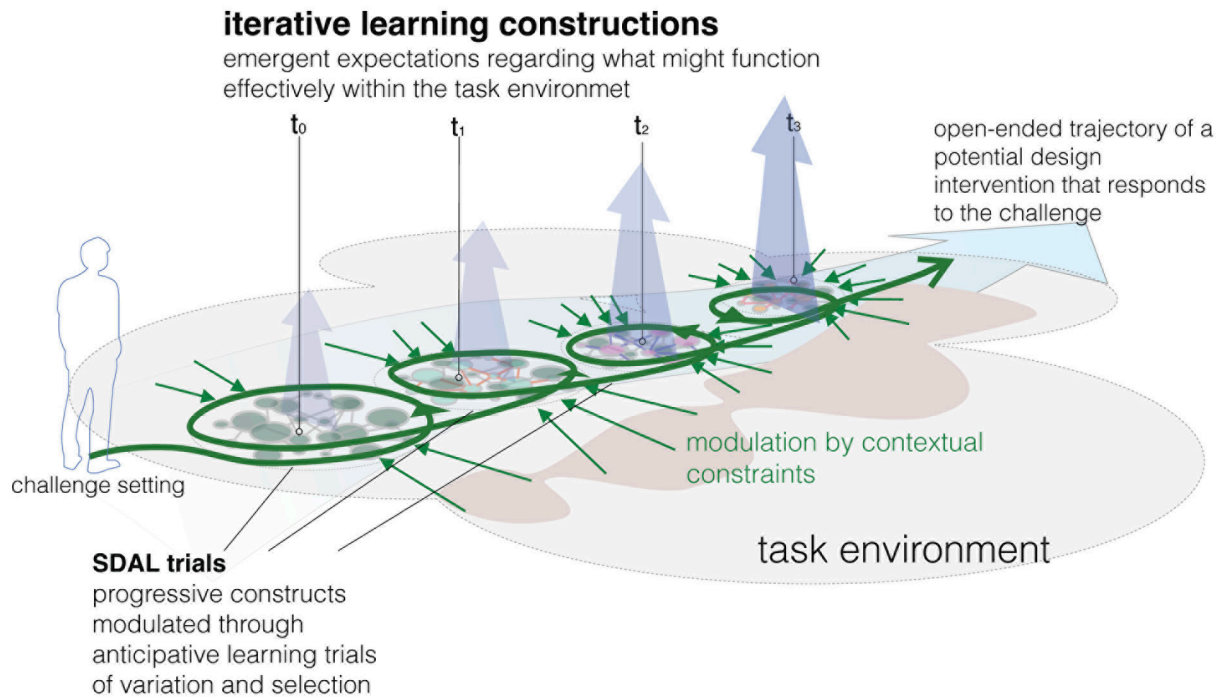


Figure 1. Anticipative modulation within a single-level task environment. The diagram summarizes Self-Directed Anticipative Learning (SDAL) as a sequence of iterative learning trials (t_0 – t_3), where each circled construction depicts a reorganization of knowledge shaped by contextual constraints and intervention-relevant opportunities within the task environment. The trajectory shows open-ended learning in which successive trials support the revision of provisional framings before full commitment to action, without presupposing that the initial representation is already adequate.

The theoretical payoff of SDAL is that it makes anticipatory revision a necessary mechanism in open-ended ideation rather than a discretionary “iteration step.” When constraints and success criteria are still being learned, evaluation must guide reorganization during exploration, not merely sort outcomes afterward. Without a process account of this kind, “iteration” remains methodologically opaque and tends to collapse into technique-driven trial-and-error.

The constructive dynamics of SDAL can be described as internally regulated variation and selection. Donald Campbell’s (1960) account of creative thought treats novelty as arising through the generation of alternatives and their selective retention. In the I–C interpretation, these operations are not unconstrained and are not externally imposed: they are self-directed insofar as prior knowledge, evolving expectations, and current evaluations constrain what is varied and how candidate directions are compared and retained (Bickhard & Campbell, 2003). More generally, self-directed learning shapes which alternatives are explored, how attention is distributed, and how evaluative cues are weighted as the trajectory develops (Snell-Rood & Steck, 2019).

On this view, refinement is the developmental form that evaluation takes during exploration. In creativity research, refinement reduces exploratory uncertainty and supports workable outcomes (Amabile & Pratt, 2016; Csikszentmihályi, 1988). In functional ideation, that necessity regulates exploration toward candidates that can plausibly function under constraints while maintaining novelty,

reducing the risk of ideation failure (Cropley & Cropley, 2005; Runco & Jaeger, 2012). Evaluation, therefore, is not only an end-stage filter: it organizes subsequent exploration by indicating what must be revised, which directions are promising, and which demands must be negotiated before further developmental construction can proceed (Bickhard, 2024; Feldman, 1999).

In these terms, anticipative learning proceeds through exploratory trials that extend a field of possibilities and stabilization trials that provisionally consolidate what is coherent enough to carry development forward as a nearby point of stability (Bickhard, 1992, 2007, 2024). In this paper, SDAL serves as the process account of ideation under systemic complexity, including recursive and meta-recursive learning over time (R. L. Campbell & Bickhard, 1992; Farrell & Hooker, 2007a; Hooker, 2018). What this process account does not by itself settle is how stabilization can be sustained when full coherence is not yet achievable and multiple demands remain simultaneously active. Within the developmental account advanced here, self-scaffolding is therefore not separate from SDAL; it is the mechanism within the anticipative learning trajectory that keeps provisional constructions available for further development when evaluative demands cannot yet be jointly satisfied. The next subsection specifies this scaffolding function as the self-directed management of evaluative demands, through which intermediate constructions can remain workable and development can continue despite partial coherence and conflicting requirements.

2.2.2. *Managing evaluative demands within the anticipative learning trajectory*

2.2.2.1. *Metacognitive supports for continuing ideation under partial coherence*

SDAL explains how ideation can proceed as prospective revision through anticipatory trials, but it does not by itself specify the mechanism that keeps ideation workable when the current construction cannot yet satisfy the demands that ordinarily guide evaluation. In systemic ideation, this situation is common: constraints can conflict, prerequisites can be missing, and feedback can indicate misalignment without yet specifying a clear revision path (Head, 2022; Jackson, 2019; Rittel & Webber, 1973; Waddock et al., 2015). Under such conditions, ideation can collapse into premature closure or drift into uncontrolled trial-and-error.

Partial coherence becomes developmentally productive only when this instability can be detected and used as a basis for further construction. In I–C terms, a learning system must be able to detect conditions of undefined or ill-defined process in its underlying knowing system in order to recover from failed or failing interaction. Such uncertainty may indicate a lack of knowledge, a failure of anticipation, interference, novelty, or an opportunity to learn; when it is fed back into the knowing system, the system can interact with its own condition of uncertainty rather than merely continue through undirected trials (R. L. Campbell & Bickhard, 1986). This point is important for systemic ideation because the creative thinker often does not yet know which part of the construction is inadequate. What first becomes available is not a fully specified revision path, but the differentiated instability of the current trajectory: the recognition that some anticipation does not yet hold, that some relation remains underspecified, or that some evaluative demand cannot

yet be satisfied. This differentiated uncertainty creates the need for a support mechanism that can keep construction active without requiring full coherence too early.

The additional mechanism required is scaffolding. Scaffolding refers to temporary supports that enable creative construction to proceed when progress would otherwise stall. The intuitive idea is familiar from the construction metaphor: scaffolding lets work continue in regions that are not yet reachable, and it is removed once the structure becomes self-supporting (Holton & Clarke, 2006). In open-ended ideation, the relevant supports are cognitive and methodological: they reshape what is evaluated, when it is evaluated, and which parts of the emerging construction must be held stable while others remain provisional (Head, 2022).

Scaffolding keeps ideation open-ended and workable by regulating evaluation, so that intermediate constructions can be developed and stabilized before the full set of requirements is reintroduced (Bickhard, 1992, 2007, 2024). Importantly, scaffolding can become metacognitive, strengthening self-directedness through deliberate monitoring of what one is doing, why one is doing it, and how the current move advances the emerging construction (Holton & Clarke, 2006). The payoff is not simply “more ideas,” but sustained constructive traction under uncertainty: the thinker can keep building through partial coherence while preserving a principled basis for later tightening and revision.

Within the broader scaffolding literature, scaffolds are temporary and relational supports that facilitate construction or development that would otherwise be more difficult or costly. A central scaffolding function is breakdown: the reduction of an over-demanding challenge into tractable subchallenges, supports, or intermediate conditions that allow development to proceed without requiring full competence or full coherence at the outset (see Caporael et al., 2014; Griesemer et al., 2014). In the I–C paradigm, this general scaffolding function is specified developmentally as self-scaffolding: the internalized, self-directed regulation of constructive activity through which the thinker reduces complexity and uncertainty by reorganizing how the challenge is approached. This includes breaking difficult challenges into subchallenges, specifying subgoals, moving to simpler or idealized cases, using available resources, and working through smaller parts of a complex task so that construction can continue when full coherence is not yet achievable (Bickhard, 1992, 2007). In the present framework, self-scaffolding is therefore not an add-on, but the mechanism that preserves productive development when evaluation would otherwise terminate construction too early.

2.2.2.2. *Maintaining idea development through nearby points of stability*

Building on the impasses described above, interdependencies and delayed feedback in systemic ideation often reveal misalignment before they reveal a fully specified revision path (Jackson, 2019; Waddock et al., 2015). When multiple demands become simultaneously active but cannot yet be satisfied together, continuing requires deciding which demands will be used to judge progress now and which will be temporarily deferred until the construction becomes more developed (Head, 2022; Rittel & Webber, 1973). Continuing then requires construction to move toward a nearby point of stability that can carry development forward (Bickhard, 1992, 2007, 2024).

This regulation becomes operational through timing and scope. Some demands cannot be satisfied now without terminating the trajectory, but they remain relevant and must be re-engaged later. Self-scaffolding therefore specifies which demands regulate progress now, which demands are temporarily deferred, and which aspects of the construction must remain stable while others remain provisional. The resulting intermediate constructions are not “solutions.” They are nearby points of stability in the I–C developmental sense: stable enough to function as supports for further construction, but not yet required to satisfy every active demand simultaneously (Bickhard, 1992, 2007). This is why self-scaffolding is not reducible to “simplifying the task.” It preserves developmental potential by enabling a construction to survive long enough to become a basis for further reorganization, including later tightening of constraints and reintroduction of previously deferred demands.

In SDAL terms, nearby points of stability are what allow anticipatory trials and prospective revision to continue when full coherence is not yet achievable. Self-scaffolding sustains the trajectory by narrowing what must be satisfied now, stabilizing an intermediate construction. Once that construction becomes sufficiently evaluable, broader or stronger demands can be reintroduced (Bickhard, 1992, 2007).

This logic has a clear analogue in research on scaffolding creative design and ill-structured problem solving. Scaffolds are used to prevent evaluation from constraining construction too early by keeping exploration active through iterative questioning, elaboration, and revision, while helping creative thinkers recognize constraints and refine ideas as the task becomes more intelligible (Hathcock et al., 2015; Lee & Kolodner, 2011). In ill-structured design domains, scaffolding prompts also support monitoring, justification, and evaluation when the next revision step is not yet evident (Ge et al., 2005). The relevant connection is the timing of evaluative constraint: many failures in systemic exploration are failures of demanding full coherence too early, rather than failures of novelty per se. Self-scaffolding preserves the developmental trajectory by allowing construction to proceed through nearby points of stability without forfeiting later convergence (Bickhard, 1992, 2007).

This scaffolding logic also prepares the developmental role of reflective abstraction. Nearby points of stability are not only temporary supports for continued construction; they also make aspects of the current organization available for further differentiation. In the knowing-levels model, this is the role of reflective abstraction: properties implicit in a stabilized organization can become available for higher-level differentiation and reorganization (R.L. Campbell & Bickhard, 1986). In systemic ideation, this means that a stabilized construction can become an object of further reflection: its assumptions, dependencies, missing supports, and possible consequences can be differentiated and reorganized at a higher level. The movement through nearby points of stability therefore does not merely preserve ideation under uncertainty. It creates the conditions under which lower-level constructions can be reflected upon, reorganized, and coordinated with broader evaluative demands.

SDAL specifies the anticipatory trial structure through which constructions are explored and revised as exploration unfolds. Self-scaffolding specifies what SDAL alone does not settle: how that revision can continue when multiple demands are active but not jointly satisfiable. Together with reflective abstraction, this establishes the basis for the next section: once ideation can be sustained through nearby points of stability, it becomes possible to specify how intervention opportunities are constructed as branching trajectories and then progressively stabilized, reflected upon, and reorganized across iterations.

2.3. Trial dynamics of systemic ideation: developing intervention opportunities

This section specifies what SDAL's anticipatory trials operate on in systemic ideation: branching intervention opportunities that emerge as creative thinkers explore trajectories of possible change across interdependent constraints, guided by evolving design challenges and provisional evaluative criteria for what counts as viable at a given stage. Building on the preceding account, these trajectories are not only sustained through self-scaffolding. They also become developmentally available through reflective abstraction, because stabilized constructions can be examined for implicit assumptions, dependencies, missing supports, and possible consequences that must be made explicit at a higher level of organization. As shown in Figure 2, intervention opportunities branch through exploratory trials, are selectively stabilized through stabilization trials, and may require rebuilding when higher-order stability exposes missing lower-level supports. This focus isolates the parts of the mechanism that Section 3 operationalizes in IDEAS: how intervention opportunities are generated, selectively stabilized, reflected upon, extended, and reworked as constraints and evaluative criteria evolve during systemic ideation.

2.3.1. Constructing intervention opportunities through exploratory trials

In the preceding sections, SDAL framed exploration as anticipatory variation that remains revisable under evaluation. In systemic ideation, what varies is not a set of isolated candidate ideas, but the evolving organization of one or more trajectories of possible change across interdependent aspects of the task environment, oriented by the current design challenges. In I–C terms, representation is grounded in differentiation: anticipations of possible outcomes implicitly differentiate classes of environmental conditions by what would happen in interaction, and those differentiated possibilities can then guide further construction (Bickhard & Terveen, 1995). In the present argument, these anticipatory differentiations are specified as indications of intervention potentiality, which the design-facing formulation treats as intervention opportunities: revisable constructions that differentiate what would have to hold for a change to work, what would likely follow if it is pursued, and where the current trajectory is likely to fail. As engagement proceeds, tentative alternatives are progressively adjusted as these differentiations become more usable, clarifying enabling conditions, constraints, and downstream consequences relevant to the current aims (Bickhard, 1999; R.L. Campbell & Bickhard, 1986). This framing is compatible with divergence in creativity research, but here divergence is treated as anticipatively modulated trial activity within an evolving

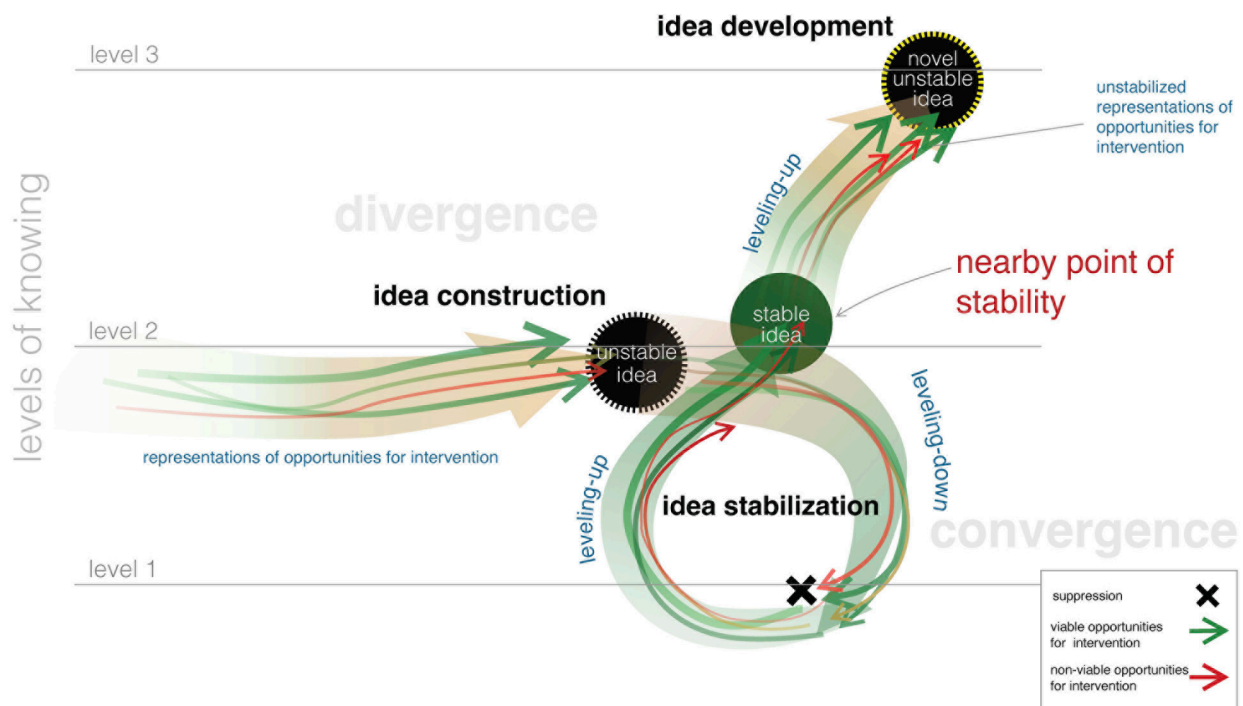


Figure 2. Trial dynamics of systemic ideation as branching, stabilization, and self-scaffolded rebuilding. The diagram shows how intervention opportunities develop as branching trajectories rather than as isolated alternatives. Exploratory trials open provisional directions for change by differentiating possible intervention potentialities within the task environment. Stabilization trials then test whether some trajectories can reach nearby points of stability, where partial coherence is sufficient to support further development without treating the candidate as a final solution. When higher-level stabilization exposes missing lower-level supports, the trajectory redirects toward self-scaffolded rebuilding rather than regress. The figure therefore summarizes the developmental logic specified in Section 2: systemic ideation proceeds through anticipatory exploration, selective stabilization, reflective reorganization, and reconstruction of the supports required for continued viability.

representation, which then enters the branching, stabilization, and rebuilding trajectory summarized in Figure 2 (Cropley, 2015).

Exploration therefore proceeds as a developmental variation-and-selective-retention dynamic: exploratory trials generate alternative pathways, while evaluation retains and further develops only those that remain coherent enough to carry the trajectory forward, with both the pathways and what counts as coherence remaining open to revision as engagement proceeds (Bickhard, 1999, 2006). Because interdependencies generate ripple effects, revisions in one part of the construction can force reorganizations within elements, among relations at the same level, and across levels of organization, so exploration tends to develop through branching adjustments rather than converging on a unified representation at the outset (Bickhard, 1999).

Exploratory trials do not yield finished ideas. They yield novel but unstable constructs whose viability is still underdetermined because the branch has not yet been tested against the full set of constraints that will later regulate appropriateness. The immediate output is therefore a provisional field of intervention possibilities: novelty is gained by opening reorganization directions, but downstream incoherence, missing supports, and constraint conflicts may only become visible as

engagement continues. For this reason, the emergent opportunities are not candidate solutions but candidate trajectories that require further developmental work before they can be stabilized as workable rather than merely possible.

2.3.2. *Branching intervention opportunities as trajectories of reorganization*

The branching and trajectory character of these intervention opportunities is not introduced as a metaphor. It follows from the Interactivist–Constructivist treatment of representations as anticipatively constructed and revisable indications of intervention potentiality that can be tested and falsified through subsequent engagement (Bickhard, 2024). In contexts of high complexity, the relevant possibilities for action are not confined to discrete artifacts but can also be shaped by broader sociomaterial, organizational, and infrastructural conditions (Norman, 2008; Xenakis & Arnellos, 2013, 2014, 2025). For methodological economy, Section 3 operationalizes these indications of intervention potentiality as systemic affordances (SysAf), when they are treated as situated possibilities for reorganization within IDEAS.

Representation of such intervention possibilities imposes constraints on how anticipations can be organized, while learning and development require constructive change that is heuristically guided rather than random. Bickhard and Campbell (1996) describe this convergence as a consequence of interactivism itself: because exploration must be revisable under error, it implies constructive change through variation and selection at the level of learning and development, and this constructive change has its own structured developmental pathways. In systemic ideation, this provides a basis for treating emerging intervention possibilities as branching trajectories of representational development rather than as a set of isolated proposals. Concretely, these possibilities are organized through directional relations: some indicate enabling conditions and constraints that other possibilities depend on, while others indicate likely downstream effects. Alternative branches therefore embody different assumed relations, and they are revised as those assumptions are tested. Branching, selective retention, and later rebuilding are therefore not add-on steps but expected consequences of how interactive representation and constructive change must cohere over time (Bickhard, 2024; Bickhard & Campbell, 1996). This is why the main developmental problem is not only how novel branches are generated, but how they are selectively stabilized into nearby points of stability so that appropriateness can be progressively achieved without prematurely eliminating novelty.

2.3.2.1. *Stabilization trials: sustaining development through nearby points of stability*

Not all indications of intervention potentiality equally support viable ideation. An intervention opportunity can be novel without being appropriate, or appropriate without sustaining innovation. Functional creativity depends on whether the integration of such opportunities yields an idea trajectory that is both novel and developmentally viable (Cropley & Cropley, 2005), capable of introducing systemic change while remaining aligned with overarching goals. Accordingly, viability is not an inherent property of any single opportunity, but of the representational trajectory that emerges through their modulation and integration (Xenakis & Arnellos, 2025).

As branching trajectories expand the space of intervention possibilities, continued development requires a complementary trial function that can selectively consolidate what is coherent enough to be carried forward. Drawing on the I–C account of constructive variation, selective retention, self-scaffolding, and nearby points of stability, the present framework specifies this role as stabilization trials. Stabilization trials do not aim to finalize an intervention. They evaluate whether a developing construction can meet a minimal coherence threshold under the evaluative criteria that are currently tractable, and they retain only those trajectories that can sustain further development (Bickhard, 1992, 2007, 2024). In this sense, stabilization is selective retention under constraint, not an end-stage filter applied after an idea is already fixed.

Within self-scaffolding, stabilization trials function as feedback-sensitive monitoring and control across iterations. They track whether the evolving construction remains coherent with the evaluative criteria that currently regulate progress, and they indicate when a trajectory should be reinforced, redirected, or provisionally set aside. The thinker can modulate the trajectory by selectively reinforcing indicated opportunities that support continued development and by suppressing those that are temporarily misaligned with the current coherence requirements. Here, suppression does not mean elimination. It is the strategic backgrounding of indicated opportunities that are not currently integrable, preserving their developmental potential while preventing interference with the construction that is being stabilized. This demand management is not limited to stabilization. It can also protect exploration when novelty becomes fragile or blocked, by reducing representational interference and allowing alternative anticipations and reorganizations to become available (Bickhard, 1992, 2007, 2024). As Figure 2 indicates, stabilization does not close the trajectory; it produces a temporary point of coherence from which further branching, higher-level reflection, or rebuilding can proceed.

When stabilization trials succeed, they yield provisional forms of partial coherence that can carry the trajectory forward while remaining revisable (Bickhard, 1992, 2007; Christensen, 2004). In the terms introduced in Section 2.2.2.2, these function as nearby points of stability: localized supports that allow intervention opportunities to be tested, integrated, and transformed under progressively broader evaluative criteria.

2.3.2.2. Self-scaffolded rebuilding across levels: when higher-order stability exposes missing supports

Branching trajectories do not only develop by extending promising possibilities forward. They can also require the rebuilding of prior supports when higher-order stabilization exposes conditions that lower-level organization cannot yet satisfy. This movement should not be understood as regress. It is a self-scaffolded return to prior organization, guided by demands that become visible only after a higher-level trajectory has stabilized enough to be examined. Figure 2 captures this recursive movement by showing that a stabilized higher-order direction can redirect construction toward prior supports rather than simply extend the branch forward.

This point follows from the relation between nearby points of stability and knowing levels. In the I-C paradigm, development proceeds through constructed organizations that survive selection and then become foundations for further construction (Bickhard, 1992, 2007, 2024). At the same time, higher-level knowing cannot be constructed independently of lower-level organization, because higher-level knowing depends on properties that are already implicit in lower-level processes and can become explicit through reflective abstraction (R.L. Campbell & Bickhard, 1986). A higher-order construction therefore does not float above previous constructions. It depends on them as supports, even when the creative thinker has not yet made those supports explicit. When a higher-level construction becomes stable enough to guide further ideation, it may reveal that some lower-level relation, prerequisite, sequence, or functional support is still insufficient.

In systemic ideation, a nearby point of stability at a higher level therefore does not complete the trajectory. It can become a diagnostic standpoint from which missing supports at prior levels become visible. For example, an intervention trajectory may become coherent at the level of social trust, collective accessibility, or long-term adaptability, but this higher-level coherence may expose that the interaction-level sequence, service relation, institutional arrangement, or technical function needed to sustain it has not yet been constructed. The required movement is not a return to an earlier idea as a discarded version. It is a return to a prior support as a site of further construction, where the lower-level organization must be reorganized or rebuilt so that it can carry the higher-level direction.

This is also the point at which the content of the design challenge can be updated. The challenge is not clarified only before ideation begins; it is progressively specified as stabilization trials reveal which evaluative criteria can actually regulate the developing trajectory. When a criterion proves capable of identifying what must be retained, what must be deferred, and what lower-level support is missing, it becomes more than an external measure of success. It refines the operative content of the challenge by specifying what the construction must now make possible. Stabilization at the higher level therefore enables the operative content of the challenge to be revised, and this revised challenge redirects rebuilding at prior levels.

Self-scaffolding supports this movement by temporarily narrowing the active evaluative demands. The higher-level direction is retained as a provisional evaluative criterion for what the lower-level rebuilding must support, while full systemic evaluation is deferred until the necessary supports have been reconstructed. Evaluative criteria are not equated with higher-level goals here; rather, they operate within the current feedback loop by indicating what must be stabilized for the next constructive move. In this sense, rebuilding is developmental: the trajectory continues through points of stability, but those points can reorganize the relation between levels. A later point of stability can make earlier supports newly problematic, and the reorganization of those supports can then make the higher-level trajectory more viable.

This is why stabilization trials must be explained as metaprocesses of self-scaffolding rather than as final evaluative checkpoints. They do not merely select which branch survives. They determine whether the current branch has the lower-level supports required to continue developing,

whether the operative challenge must be refined, and whether the evaluative criteria guiding the trajectory are sufficient for further construction. When these supports are missing, stabilization redirects construction toward the level that must be reorganized or rebuilt, while preserving the higher-order trajectory that made the missing support visible.

Accordingly, rebuilding across levels is not a deviation from systemic ideation but one of its central developmental movements. Exploratory trials open possible trajectories, stabilization trials identify nearby points of stability, and reflective abstraction makes implicit dependencies available for higher-level differentiation. Once these dependencies become explicit, the Scaffold can redirect attention to the prior supports that must be reconstructed. The trajectory then continues not by abandoning the higher-level construction, but by rebuilding the lower-level organization required to sustain it.

Accordingly, Section 2.3 establishes the trial dynamics that any later methodological architecture must preserve. Intervention opportunities are generated as branching trajectories, not as isolated alternatives; they are stabilized through selective retention, not finalized through premature evaluation; and they remain open to reflective abstraction and self-scaffolded rebuilding when higher-order stability exposes missing prior supports. These dynamics clarify what must be methodologically supported later: the generation of multiple intervention trajectories, the stabilization of partial coherence, the explicit use of evaluative criteria, the revision of design challenges under feedback, and the rebuilding of lower-level supports when higher-order development requires them.

2.4. Hierarchical organization in creative thinking and complex systems

2.4.1. *Developmental possibilities for intervention require the hierarchical organization of representations and goals*

Developmental possibilities for intervention require hierarchical organization because novelty, in the strong creative sense, cannot be reduced to variation within an existing level of organization. Here, development does not designate incremental progress within the same level of organization; it designates the constructive emergence of a higher level of organization from prior constructions that have become available as supports for further reorganization. Creativity can therefore be treated as a particularly powerful form of development: it involves a purposeful transformation of knowledge significant enough to change that knowledge from what it was before, and creative accomplishment is a developmental shift in which knowledge and understanding are substantially reorganized (Bickhard, 2006; Feldman, 1989, 1999). This point is central for systemic ideation. If novelty is only produced by varying alternatives within a current representational level, ideation can generate refinements, adaptations, or recombinations, but it cannot explain how a new level of organization becomes available. Higher-order novelty requires movement to a higher level of abstraction, where the current construction can be reflected upon, reorganized, and oriented by broader evaluative demands.

SDAL explains how this movement can remain exploratory and revisable under feedback, but it does not by itself explain how a construction becomes available for higher-order reorganization. This role is provided by reflective abstraction. Once a construction reaches a nearby point of stability, properties implicit in its organization can become available for explicit differentiation at a higher level of knowing (R.L. Campbell & Bickhard, 1986). At that higher level, the creative thinker can examine the construction's assumptions, dependencies, limits, and consequences, rather than merely modifying the construction from within its current form. Novelty becomes developmental at this point because the object of change is not only the candidate intervention, but the organization through which that intervention is made meaningful, evaluable, and extendable.

This higher-level movement also requires the co-organization of intervention challenges and intervention opportunities. In the I–C paradigm used here, motivation and representation are not separate domains added to each other. They are functional aspects of the same anticipatory organization. For this reason, an intervention challenge and an intervention opportunity must be understood as operating at the same processing level: the challenge specifies the evaluative orientation of the constructive activity, while the opportunity specifies the emerging representational content through which that orientation may be pursued, revised, or transformed (Bickhard, 2003). In systemic ideation, challenges are therefore not fixed goals placed outside ideation, and opportunities are not neutral contents generated independently of evaluation. They co-develop within the same constructive trajectory, because what counts as an opportunity depends on the challenge that currently organizes relevance, while the challenge itself can be revised when emerging opportunities reveal new dependencies, missing supports, or more adequate directions for intervention.

Carver and Scheier's account of goal hierarchies clarifies how the co-organization of intervention challenges and intervention opportunities can remain regulative across levels of abstraction. Their cybernetic account is concerned with the how of motivated behavior rather than the what: it specifies the structure and dynamics through which goal-directed action is regulated, without determining the substantive content of the goals themselves (Carver & Scheier, 2012). Goals are organized hierarchically, and broader goals depend on more specific subgoals that make progress assessable through feedback. More specifically, a feedback loop includes an input function, a reference value, a comparison process, and an output; the comparison between current input and the reference value makes deviation detectable and supports corrective regulation (Carver & Scheier, 2012, 2017). This cybernetic structure does not replace SDAL. Rather, it specifies the feedback-control organization through which evaluative criteria can operate within the anticipative learning trajectory. In the present argument, this does not mean that goal levels are identical to knowing levels. Rather, it means that intervention challenges can be structured across levels so that each challenge is paired with intervention opportunities at the same processing level, while lower-level subgoals or reference values specify what must be maintained, achieved, or corrected for the higher-level orientation to remain regulative.

In the general account developed so far, these regulatory demands have been described as evaluative criteria. When such criteria are organized within a goal-directed feedback loop, they can

be specified more precisely as reference values, namely target conditions that indicate what must be maintained, achieved, or corrected for the goal-directed process to remain regulated. At a given processing level, an intervention challenge organizes the evaluative orientation of ideation, while intervention opportunities specify the emerging representational content through which that orientation may be pursued. The evaluative criteria that make the challenge assessable therefore function as reference values when they specify how deviation from the intended direction can be detected and corrected.

Crucially, reference values are not fixed once and for all. As Section 2.3.2.2 showed, stabilization can revise the operative content of the design challenge when emerging intervention opportunities make new dependencies, limits, or missing supports visible. This means that design representations and evaluative criteria co-develop: emerging intervention opportunities can revise the operative challenge, while the revised challenge can reorganize which reference values are used to assess further development. Lower levels do not assess or control higher ones. Rather, higher-level challenges remain regulative by being specified through lower-level subgoals or reference values, which make deviation detectable and further reorganization possible.

This hierarchical organization prepares the connection to complex sociotechnical systems without yet performing the methodological alignment developed in Section 3. The claim here is narrower: higher-order novelty in systemic ideation requires movement across levels of abstraction, and such movement must be both representationally possible through reflective abstraction and evaluatively directed through feedback-regulated reference values. Section 2.4.2 extends this argument by showing that complex sociotechnical systems also exhibit layered forms of organization, regulation, and constraint.

2.4.2. Hierarchical ideation in the context of sociocultural and sociotechnical systems

The demand for a structured hierarchy does not arise from cognitive development alone. It also reflects how complex systems are organized to regulate transformation. Sociotechnical and sociocultural systems, such as mobility, education, or healthcare, are not flat networks. They are layered arrangements of interdependent subsystems, each operating at different levels of function, meaning, and regulation (Banathy, 1996; Capra & Luisi, 2014; Jackson, 2019).

Such systems adapt through recursive feedback loops, where change at one level influences and is influenced by others. Systemic outcomes are therefore not the result of isolated actions, but of relations among goals, constraints, and regulatory dependencies operating across levels (Boulton et al., 2015). For example, while a university may aim to advance knowledge, its internal departments act on more specific operational demands, including funding, rankings, teaching loads, and administrative obligations. These demands can support the broader purpose when they remain coordinated, but they can also generate fragmentation when local regulation becomes disconnected from higher-level orientation.

In these systems, transformation cannot occur at random points. Higher-level systemic purposes constrain what counts as desirable change, while lower-level arrangements specify the conditions through which those purposes can become operationally viable. At the same time, bottom-up shifts can gradually alter, destabilize, or redirect higher-level orientations when existing arrangements no longer sustain coherence (Checkland & Poulter, 2020; Jackson, 2019). Transformation is viable only when it engages this layered structure, maintaining coherence across internal dynamics, external pressures, and evolving reference conditions.

In this sense, hierarchical ideation is not a cognitive preference imposed on systems from outside. It becomes necessary because both sides of the relation are level-sensitive: creative ideation develops through levels of knowing and evaluative abstraction, while complex systems regulate themselves through layered functional and organizational dependencies. If creative thinking is to generate interventions that are viable within such systems, it cannot proceed as a single-level search. Design challenges must be constructed in relation to the system's layered goals, constraints, and reference conditions, so that ideation remains sensitive to how local changes affect broader systemic coherence. Without this level-sensitive organization, interventions may remain locally effective but systemically narrow, reactive, or misaligned with the conditions they are meant to transform.

This systemic logic is compatible with the developmental logic described in Section 2.4.1. Just as higher-order novelty in thought requires stabilized prior constructions to become available for reflective abstraction, systemic transformation often requires stabilized arrangements to be revisited when higher-level purposes, constraints, or reference conditions shift. The claim is not that sociotechnical systems instantiate reflective abstraction or self-scaffolding as cognitive processes. Rather, the structural analogy is that both creative development and systemic transformation require level-sensitive reorganization: higher-level change can expose missing lower-level supports, and those supports may need to be reconstructed before the broader transformation can become viable. This is the systemic counterpart of the self-scaffolded rebuilding described in Section 2.3.2.2, not a form of explanatory regress.

Taken together, Section 2 has specified systemic ideation as a self-directed developmental process in which intervention opportunities are generated through anticipatory trials, stabilized through nearby points of stability, made available for higher-level reorganization through reflective abstraction, and rebuilt when higher-order development exposes missing supports. This account explains creative ideation as a process that remains self-directed because it can revise both emerging intervention representations and the evaluative criteria that guide them under feedback. Section 3 translates this account into the IDEA Design Scaffold, where the same mechanisms are operationalized through Systemic Breakdown, Systemic Integration, and the Iterative Innovation Cycle.

3. THE IDEA DESIGN SCAFFOLD: A METHODOLOGICAL ARCHITECTURE FOR SYSTEMIC IDEATION

Section 3 translates the developmental account developed in Section 2 into the IDEA Design Scaffold, a methodological architecture for organizing ideation under systemic complexity⁸. The Scaffold is structured through two coupled methodological phases. Systemic Breakdown operationalizes scaffolding by reducing the scope of evaluation: it models broad systemic goals through subgoals and reference values, so that designers can later formulate tractable intervention challenges without losing the higher-order systemic orientation. Systemic Integration then uses this working hierarchy to guide development through the Iterative Innovation Cycle, which operationalizes the stabilization and developmental feedback loops specified in Section 2.

3.1. Systemic Breakdown: structuring systemic goals across levels of complexity

Systemic Breakdown is the first methodological phase of IDEAS. It operationalizes the scaffolding function described in Section 2 by reducing the scope of evaluation without abandoning the higher-order systemic orientation. Instead of asking designers to address an ill-defined task environment as a whole, Systemic Breakdown guides them to model how systems and subsystems within that task environment are organized, focusing on interdependent goals, subgoals, reference values, and cross-level relations. Consistent with a pluralistic stance toward methods in systemic work, this phase can incorporate different mapping and inquiry methods for examining actors, infrastructures, processes, and dependencies (Jackson, 2019). Within IDEAS, however, these methods are oriented by two constraints that matter for ideation: hierarchy across levels and interconnection both between levels and within each level. The output is a working evaluative hierarchy that makes broad systemic goals assessable through more specific subgoals and reference values, so that ideation can begin from tractable intervention challenges rather than from an undifferentiated demand for systemic transformation.

This hierarchy is not a static map of the system. It is a provisional evaluative model that can be revised as ideation proceeds. Designers use Systemic Breakdown to identify how lower-level mechanisms, interactions, and organizational relations support or constrain higher-level goals. When these goal-to-reference-value relations need to be made explicit, IDEAS organizes the breakdown through Paths of Deconstruction, which are explained in the next subsection.

⁸ IDEAS has been developed and iteratively refined over three years through implementation in two core ideation design studios of the Department of Product and Systems Design Engineering, University of the Aegean, providing the practical basis from which the methodological architecture described here has been elaborated. Earlier methodological development of IDEAS has been presented in design education research (Xenakis & Grigoreli, 2025). This implementation and prior presentation are not treated here as empirical validation of the framework; empirical examination of how designers navigate the IIC in this context is the subject of ongoing work.

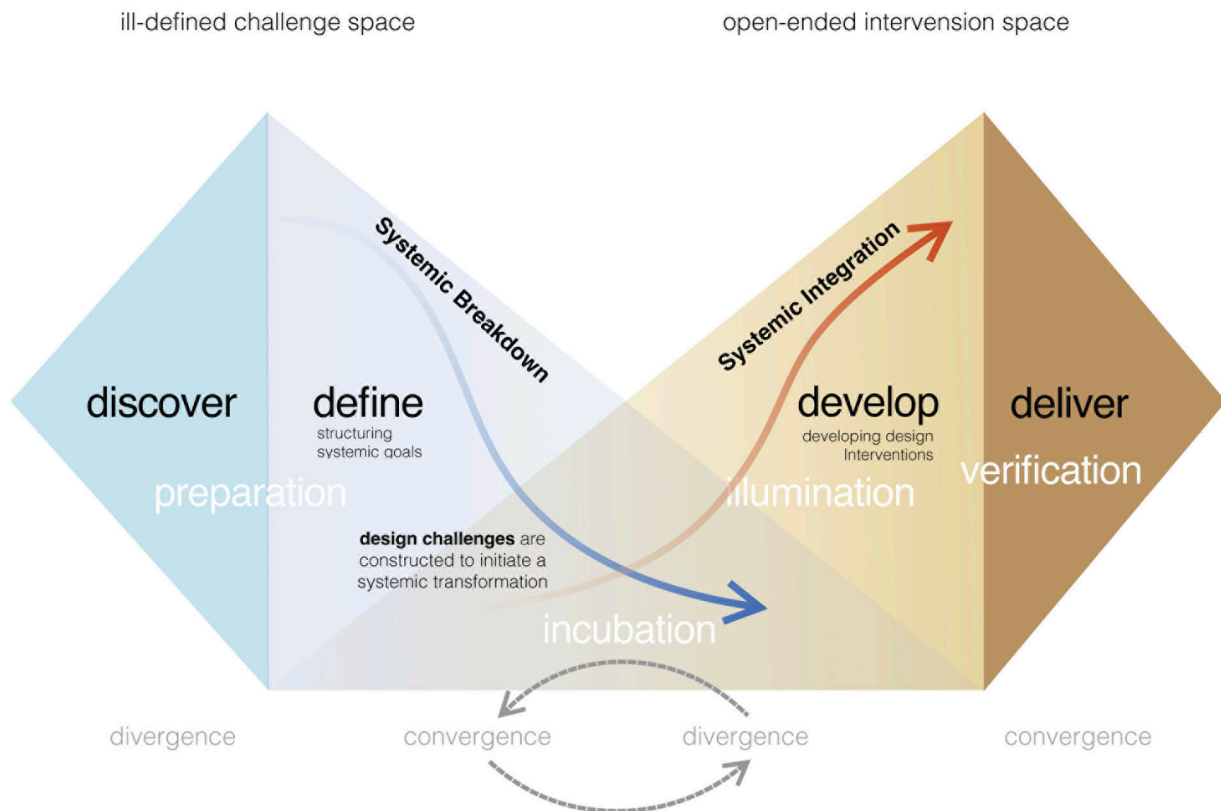


Figure 3. Systemic Breakdown and Systemic Integration as recursively coupled methodological phases in IDEAS. The diagram uses the Double Diamond as an orienting visual analogy, but reinterprets discovery, definition, development, and delivery through the IDEA Design Scaffold. Systemic Breakdown constructs a provisional evaluative hierarchy by clarifying systemic goals, subgoals, reference values, and cross-level relations. Systemic Integration uses this hierarchy to guide the construction, stabilization, extension, and revision of intervention candidates. The two phases remain coupled because intervention development can reveal missing supports, insufficient reference values, or inadequate challenge framings, which can require the evaluative hierarchy and the design challenge to be revised.

Figure 3 situates Systemic Breakdown within the overall architecture of IDEAS. The left side of the figure corresponds to the ill-defined challenge space, where systemic goals must be clarified into evaluable design challenges. The movement from “discover” to “define” represents the convergent work of constructing this evaluative hierarchy. The Double Diamond is used only as an orienting visual analogy, as IDEAS retains the distinction between convergence and divergence, but treats goal specification and intervention construction as recursively coupled under feedback rather than as sequential handoff stages (Design Council, 2022). Accordingly, Systemic Breakdown and Systemic Integration remain continuously coupled, because intervention candidates developed later may reveal that the current reference values, challenge formulation, or goal relations require revision.

3.1.1. Operationalizing complexity through systemic goal hierarchies

Systemic Breakdown begins by constructing a multilayered model of the task environment. Goal hierarchies are methodologically central to this modeling because, in systems thinking, goals are among the most powerful determinants of system behavior: they set direction, define discrep-

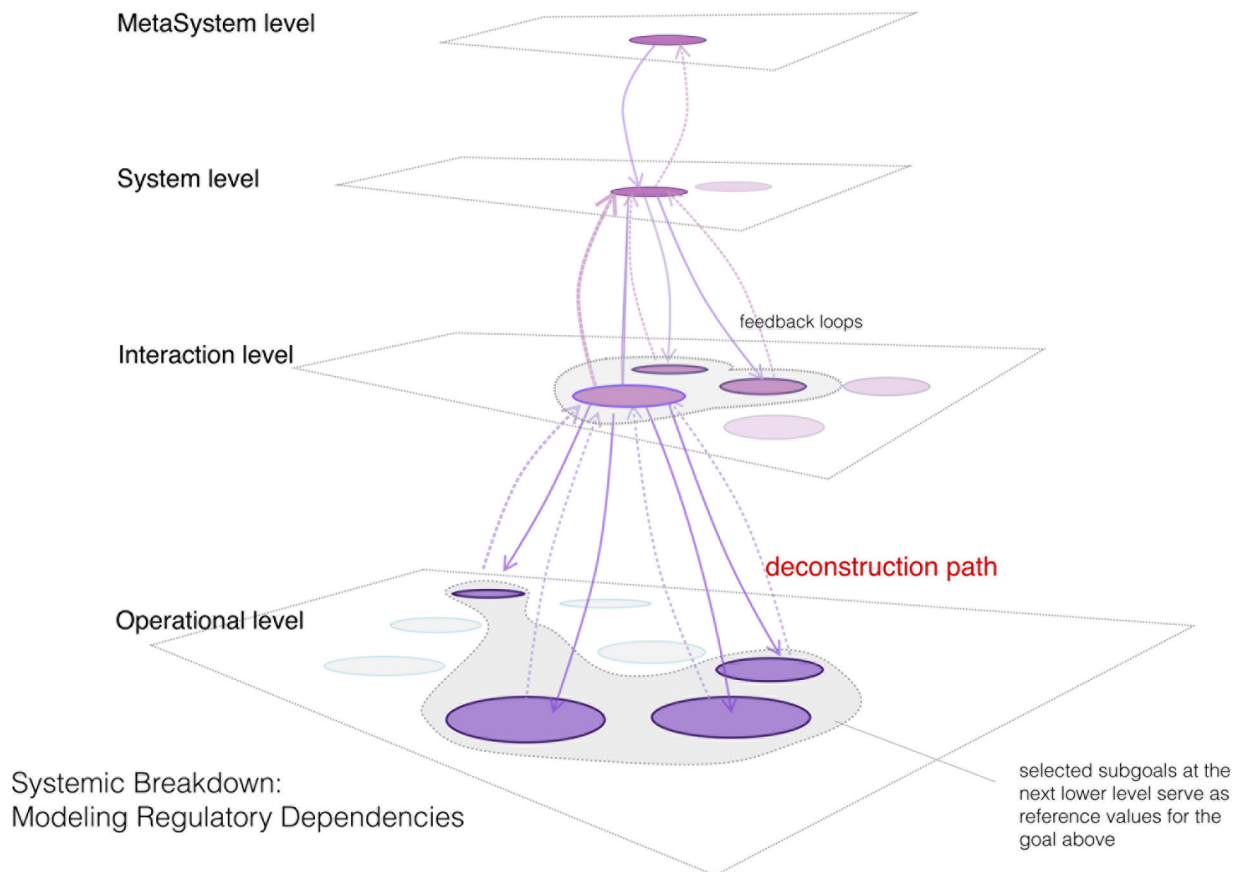


Figure 4. Systemic Breakdown: The diagram shows how Systemic Breakdown traces selected Paths of Deconstruction across the Operational, Interaction, System, and MetaSystem levels. Each path begins from a higher-level systemic goal and identifies the lower-level goals or subgoals that function as reference values, that is, evaluative conditions that make the higher-level goal assessable for later ideation. The figure does not represent a complete model of the system; it shows a selective methodological trace through which broad systemic goals become sufficiently evaluable to support the formulation of design challenges.

ancies that require action, and provide the reference conditions toward which balancing feedback loops operate (Meadows, 2008). In IDEAS, this modeling is organized through Paths of Deconstruction: selective traces that show how a higher-level systemic goal is made evaluable through a selected group of lower-level goals, which together function as reference values for that higher-level goal. These paths do not attempt to describe the whole system exhaustively. Each systemic level may contain many possible goals, but a Path of Deconstruction activates only the subset that is relevant to the higher-level goal being traced. This selected subset may stabilize, constrain, or destabilize the higher-level goal relation, while other goals at the same level may remain outside the current path or participate in another path.

Methodologically, a Path of Deconstruction is constructed top-down (Figure 4). It begins from a higher-level systemic goal and progressively selects the lower-level goal sets that make that goal evaluable. Because a systemic level contains many possible goals, Systemic Breakdown can generate several Paths of Deconstruction, each tracing a different direction of goal organization. The selected lower-level goals function as reference values when they specify what must be maintained, corrected, or reconstructed for the higher-level goal relation to guide later ideation. A single lower-

level goal may also participate in more than one path when it supports different higher-level goals. This top-down construction does not imply that system dynamics are only top-down; it specifies the methodological direction of breakdown, while the modeled system may still include bottom-up feedback and horizontal interdependencies. At this point, the designer is not yet translating the model into a design challenge. The aim is to construct a working evaluative hierarchy that can later support that translation in Section 3.2.

Theoretically, the number of levels in a systemic hierarchy is not fixed, because hierarchical modeling depends on the grain of analysis, the temporal scale of the dynamics under examination, and the part-whole relations through which higher and lower levels mutually constrain one another (Hooker, 2011; Simon, 1977; Wu, 2013). Complex sociotechnical and sociocultural systems can therefore be modeled at different levels of detail, depending on the task environment, the available evidence, and the purpose of inquiry. The four levels in Table 1 provide a provisional working scaffold for constructing Paths of Deconstruction, not a fixed claim that all systems contain exactly four levels. They are a methodological differentiation used within IDEAS to help designers keep distinct kinds of goal statements apart while moving from broad systemic goals to actionable reference values.

The levels are differentiated by two dimensions. The first is temporal horizon: hierarchy theory and near-decomposability accounts distinguish levels partly by process rate, with lower levels associated with faster and more local dynamics and higher levels associated with slower and broader dynamics (Simon, 1977; Wu, 2013). The second is cross-level systemic function: in complex systems, levels are not merely stacked layers but part-whole relations in which higher levels constrain, orient, or influence lower-level dynamics, while lower-level dynamics also condition what higher-level organization can sustain (Hooker, 2011). Within IDEAS, this means that each level is distinguished by the kind of systemic work its goals perform in this cross-level relation: mechanism and resource feasibility, coordination in use, sociocultural and ecological acceptability, and long-term purpose orientation.

Table 1. Systemic levels of the IDEA Design Scaffold as a provisional working scaffold for tracing temporal horizons and hierarchical regulatory functions

Systemic Level	Temporal Horizon	Cross-Level Systemic Function	Systemic Function for Ideation
MetaSystem Level	<i>Long-term</i>	<i>Sustainability and resilience goals orient the whole system's long-term direction</i>	<i>Defines the purpose horizon through which lower-level systemic goals can be selected and interpreted</i>
System Level	<i>Mid- to long-term</i>	<i>Sociocultural and ecological goals constrain what counts as legitimate system performance</i>	<i>Specifies value commitments that shape interaction-level coordination and operational priorities</i>
Interaction Level	<i>Mid-term</i>	<i>Integration and reliability goals coordinate lower-level mechanisms across situated use contexts</i>	<i>Specifies how operational mechanisms must work together to become stable in practice</i>
Operational Level	<i>Short-term</i>	<i>Situated functionality goals enable action through mechanisms, resources, and feasibility conditions</i>	<i>Specifies the mechanisms, resources, and feasibility conditions that make action possible</i>

At the Operational level, goals specify the mechanisms, resources, and feasibility conditions that make action possible. At the Interaction level, goals specify how those mechanisms become coordinated and reliable in situated use. At the System level, goals specify sociocultural and ecological value commitments that constrain what counts as acceptable functioning beyond local interaction. At the MetaSystem level, goals specify long-term purpose orientation, sustainability, and resilience, through which the direction of the whole system becomes evaluable. This distinction matters because complex systems can remain locally functional while becoming misaligned with broader systemic goals; Systemic Breakdown therefore helps designers identify when operational success, interaction stability, or system-level performance masks higher-level dysfunction.

Working across these levels allows designers to trace how higher-order systemic goals become evaluable through nested goal-to-reference-value relations. A deconstruction path therefore does not claim that lower-level goals contain or determine higher-level goals. It specifies which lower-level reference values must be considered so that the higher-level goal can remain assessable during later ideation. In this respect, Systemic Breakdown complements system mapping approaches that support shared sensemaking of interdependencies by adding an explicit focus on the vertical goal-to-reference-value relations through which systemic goals become evaluable for ideation (Barbrook-Johnson & Penn, 2022; Sevaldson, 2022).

This four-level structure is therefore a minimum working differentiation for IDEAS, not a closed taxonomy. Finer subdivision remains possible when a domain requires it, but the Scaffold uses these four levels to keep the main goal-to-reference-value relations visible and workable during ideation. The methodological output of Systemic Breakdown is therefore not a complete system model, but a revisable evaluative hierarchy that prepares the next step: translating systemic goal relations into designable intervention challenges. Its purpose is not merely to describe current functioning, but to identify where goal-to-reference-value relations may need to be reconfigured for transformation.

3.2. Translating systemic goal hierarchies into design challenges

The translation from systemic goal hierarchies to design challenges is not a linear conversion of goals into tasks. It is a provisional methodological step in which selected goal-to-reference-value relations are reformulated as designable targets for change. These targets do not merely restate the goals identified during Systemic Breakdown; they specify what must be reorganized in the task environment so that a different systemic trajectory can become possible. This translation remains provisional because systemic challenges are ill-defined, open-ended, and progressively clarified through engagement rather than fully specified in advance (Head, 2022; Rittel & Webber, 1973). Designers therefore do not convert the full hierarchy into a complete set of challenges at the outset. They formulate tractable challenges from selected goal-to-reference-value relations and revise them as intervention candidates reveal new dependencies, missing supports, or misaligned criteria.

Within IDEAS, this step has three methodological operations. First, designers select the systemic goals that will function as provisional evaluative anchors. Second, they specify the lower-level reference values that make those anchors assessable during ideation. Third, they formulate a design challenge as a commitment to reorganize the relevant goal relation, rather than merely improve performance within the existing configuration. This follows the systems-theoretical claim that goals and reference conditions shape how systems regulate behavior through feedback, and that changing goals or reference conditions can redirect system behavior (Carver & Scheier, 2012, 2017; Meadows, 2008). The challenge therefore functions as an evaluative orientation for intervention development: it indicates what the emerging intervention must make possible and which reference values will initially guide judgments of viability.

This distinction is important because systemic challenges do not arise only from stakeholder demands or observed failures. Stakeholders may identify disruptions, but systemic patterns such as ecological degradation, social exclusion, or infrastructural dependence can operate through feedback structures and dependencies that are not fully visible from any single position within the system (Barbrook-Johnson & Penn, 2022; Boulton et al., 2015; Jackson, 2019; Meadows, 2008). IDEAS therefore treats stakeholder input as necessary but not sufficient. Designers construct challenges by relating stakeholder concerns to the task environment's goal hierarchy and by specifying which reference values must be changed, strengthened, or newly introduced to guide transformation.

Goal refinement is therefore part of ideation work, not a preliminary step completed before ideation begins. This differs from approaches that treat requirements, stakeholder needs, or scenarios mainly as inputs to be elicited, specified, or modeled before design development proceeds (see e.g., Anton, 1996; Mate & Silva, 2004; Mylopoulos et al., 2001). In IDEAS, the working challenge remains revisable because Systemic Integration can reveal that the selected reference values are insufficient, that the hierarchy has been modeled too narrowly, or that the emerging intervention candidate changes what must count as success. In this way, Section 3.2 connects Systemic Breakdown to Systemic Integration: the former provides the evaluative hierarchy, while the latter tests and revises the challenge through intervention development.

3.3. Systemic Integration: operationalizing the Iterative Innovation Cycle (IIC)

Systemic Integration uses the evaluative hierarchy developed through Systemic Breakdown to guide the construction, stabilization, extension, and revision of intervention candidates across systemic levels. Its methodological core is the Iterative Innovation Cycle (IIC), which operationalizes the feedback dynamics specified in Section 2 through two coupled movements: a stabilization movement, in which provisional candidates constructed at the selected start level are tested against currently tractable reference values until they reach provisional coherence; and a developmental movement, in which stabilized constructions become bases for extension toward higher-level challenges or for rebuilding lower-level supports when feedback exposes missing conditions.

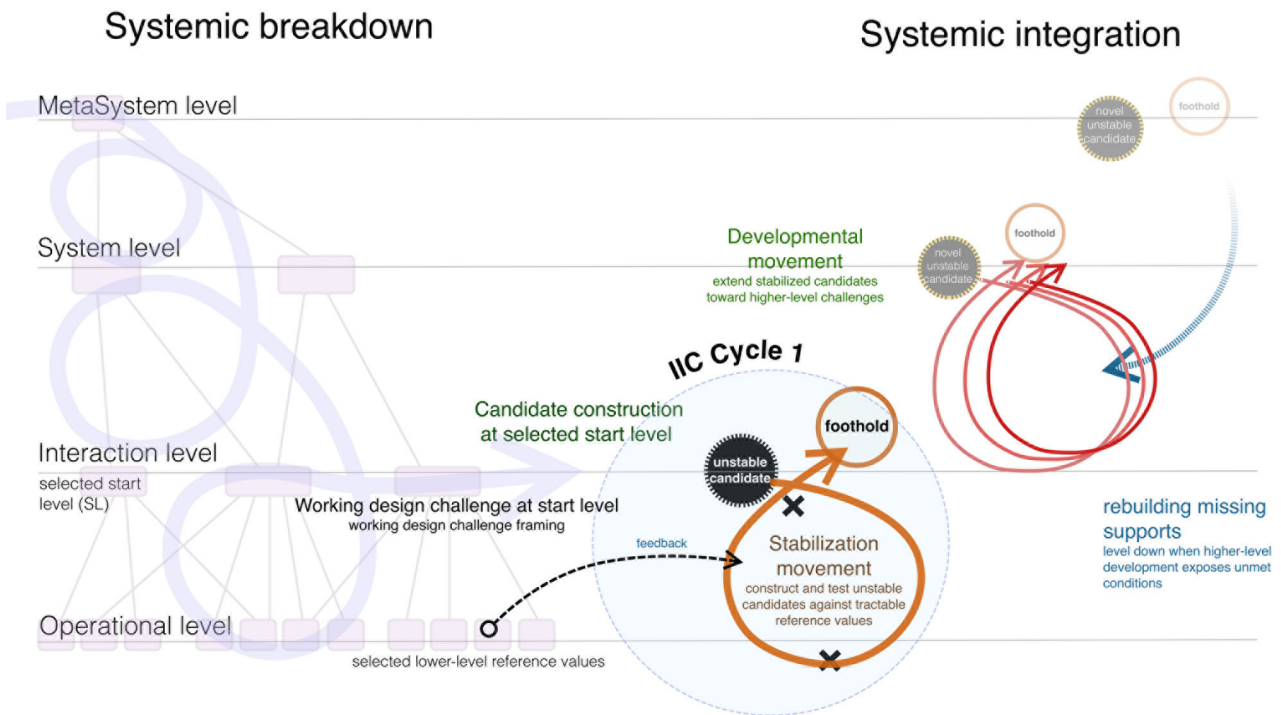


Figure 5. The IDEA Design Scaffold: Systemic Breakdown, Systemic Integration, and the Iterative Innovation Cycle (IIC). The figure provides an overview of how IDEAS connects systemic goal modeling with intervention candidate development. Systemic Breakdown constructs a cross-level hierarchy of systemic goals, subgoals, and reference values, which supports the framing of a working design challenge at a selected start level (SL). Systemic Integration operationalizes ideation through the IIC. In the stabilization movement, designers construct provisional candidates at the selected start level and test them against tractable reference values until an idea foothold is reached. In the developmental movement, the foothold becomes a basis for extension toward higher-level challenges or for self-scaffolded rebuilding when higher-level development exposes missing lower-level supports. Faded trajectories indicate repeated cycles through which successive footholds and revised candidates are developed under feedback.

Figure 5 then provides the overview of the IDEA Design Scaffold and shows how the IIC is enacted within Systemic Integration through evaluative anchors, footholds, and recursive movement across levels. The following sections operationalize these two movements.

3.3.1. Constructing and stabilizing provisional candidates

The stabilization movement begins by selecting the start level (marked as SL in Figure 5), that is, the level in the working hierarchy where the design challenge can be explored through concrete intervention candidates without collapsing into the full complexity of the task environment. This level is not automatically the Operational level. It is chosen relative to the design challenge, the available reference values, and the degree of evaluative specification already achieved through Systemic Breakdown. If designers begin too low, they may generate candidates that are technically feasible but weakly connected to the systemic goal relation targeted for transformation. If they begin too high, the challenge may remain too abstract to support constructive ideation. The start level therefore sets the first evaluative frame of the IIC: it specifies which reference values will initially guide viability assessment and which goal relation is being targeted for reorganization.

At this point, designers begin to identify systemic affordances, hereafter SysAf. In IDEAS, SysAf are method-facing indications of intervention opportunity: conditions, relations, tensions, or dependencies in the task environment that become relevant as possible sites of intervention when interpreted through the current design challenge and its selected reference values (Xenakis & Arnellos, 2013, 2014, 2025). SysAf are not fixed properties simply found in the environment. They are constructed during ideation as designers relate detected systemic conditions to what the design challenge requires the intervention to change, support, or make possible. Their function is therefore to make intervention potentialities visible and workable at the selected start level.

These SysAf are then combined into provisional candidates, which IDEAS calls archetypes⁹ of intervention. Archetypes are unstable configurations of SysAf that externalize different possible directions for reorganizing the selected goal relation. Their value lies in making divergence evaluable: instead of generating unrelated alternatives, designers construct several provisional candidates that can be compared against the selected reference-value set. As Figure 5 indicates, this first movement begins with challenge framing and archetype construction at the selected start level, producing novel but unstable candidates that must then be tested through stabilization trials.

Stabilization trials test whether these provisional candidates can reach a minimal coherence threshold under the currently tractable reference values. In the IIC, these tractable reference values are usually selected from the next lower level, because stabilization requires testing whether a candidate constructed at the start level can be supported by more concrete mechanisms, resources, or feasibility conditions. This does not mean that the candidate must satisfy the full systemic hierarchy. It means that the candidate must become coherent enough to support further development. Designers therefore compare unstable candidates by asking whether their SysAf can be supported by the selected lower-level reference values, whether they depend on conditions that are not yet available, and whether some aspects must be suppressed, deferred, or revised before the candidate can continue. As discussed in Section 2.3.2.1, suppression does not mean elimination. It means temporarily backgrounding variants or demands that cannot yet be integrated without destabilizing the construction.

When stabilization succeeds, the candidate becomes what IDEAS calls an idea foothold: the design-methodological translation of a nearby point of stability, as defined in Section 2.2.2.2. It is a provisional construct that can carry feedback forward into the next movement of the IIC, but it is not stable enough to be treated as a finalized intervention. A foothold does not terminate ideation and should not be treated as a solution. It provides a working point of stability that allows designers to continue development under feedback. It preserves the selected candidate, clarifies which reference values currently make its viability assessable, and reveals which aspects of the challenge may need to be revised before broader systemic development can proceed.

9 The term “archetype” is used methodologically here to designate early, unstable configurations that give designers a way into the intervention space. This use is consistent with design-process research showing that designers often begin with a limited generator or small set of objectives that reduces the range of possible directions and makes subsequent testing possible, rather than first specifying all requirements in detail (Darke, 1979).

The methodological output of this movement is not a final concept, but a stabilized provisional candidate. The IIC begins with unstable candidates because novelty requires divergence, but it cannot continue without stabilization. By moving from SysAf to archetypes and from archetypes to footholds, Systemic Integration turns divergent construction into a feedback-sensitive basis for further development. This prepares the second movement of the IIC, in which stabilized candidates are extended toward higher-level challenges or redirected toward lower-level supports that must be rebuilt.

3.3.2. *Developing ideas and rebuilding missing supports*

Once a foothold has been established, Systemic Integration enters the developmental movement of the IIC. The foothold provides enough stability for the designer to treat the candidate as a basis for further development, but not enough stability to treat it as a completed intervention. Its methodological role is to make further differentiation possible. Because the candidate has been tested against selected reference values, the designer can now examine what the stabilization process has revealed about the task environment, the design challenge, and the supports required for continued development.

This movement is not a simple scaling-up of the candidate. Designers use the foothold to ask what additional SysAf, relations, and organizational conditions become visible when the candidate is considered under broader systemic goals and longer temporal horizons. In this sense, development reintroduces divergence, but it does so from a stabilized base. The new candidate does not begin from an undifferentiated search space; it inherits partial coherence from the foothold while opening a broader field of possible reorganization at the next higher level of the working hierarchy.

At this point, the design challenge also develops. Stabilization does not only select a candidate; it clarifies what the challenge actually requires. When designers examine why a foothold worked, where it remained fragile, and which reference values were insufficient, they differentiate the task environment more precisely. New dependencies, missing supports, unrecognized constraints, or previously implicit tensions can become visible. The challenge structure therefore co-evolves with the developing idea: the stabilized candidate changes what can be seen in the task environment, and this improved differentiation can revise what the challenge must ask the next ideation cycle to address.

The developmental movement therefore expands the working reference-value structure. Some reference values may remain stable because they continue to make the candidate's viability assessable. Others may need to be refined, replaced, or supplemented because the foothold reveals that the original challenge framing was too narrow or that the selected reference values were not sufficient to guide higher-level development. This does not mean that lower levels control higher levels. Rather, it means that the higher-level challenge becomes more adequately specified as the designer learns which lower-level conditions must be maintained, corrected, or reconstructed for the candidate to remain viable.

When the foothold can support higher-level exploration, the designer extends it toward broader systemic challenges. This extension asks whether the stabilized candidate can reorganize relations at a wider scope, for example by supporting trust, accessibility, resilience, or long-term adaptability rather than only local coordination or operational feasibility. The resulting higher-level candidate is again provisional. It must be tested against the reference values that make the broader challenge evaluable, and it may generate new SysAf that were not available at the original start level.

When higher-level development exposes missing conditions, the movement turns toward rebuilding. This should not be described as regress. It is a self-scaffolded return to lower-level supports that must be strengthened, revised, or newly constructed so that the higher-level candidate can become evaluable and stabilizable. In practice, this means that the designer identifies which mechanisms, resources, interaction sequences, organizational relations, or feasibility conditions are missing or inadequate, and then redirects development toward reconstructing those supports. The higher-level direction is not abandoned; it becomes the reference orientation for rebuilding what the lower levels must now provide.

The methodological output of this movement is therefore a revised developmental trajectory. The stabilized candidate is extended toward a broader challenge when its supports are sufficient, or redirected toward rebuilding when those supports are missing. In both cases, the design challenge and the idea develop together: the idea makes new aspects of the task environment visible, and the revised challenge reorganizes which reference values guide the next cycle. The IIC therefore sustains systemic ideation by moving from footholds to higher-level development, and from higher-level development back to the lower-level supports required to make transformation viable.

4. CONCLUSIONS

The problem addressed in this paper is both practical and theoretical. Systemic design has developed strong ways to frame complexity, map interdependencies, support participation, and coordinate intervention work, but the development of intervention candidates within such complexity still requires clearer specification. Creativity frameworks explain important aspects of novelty, variation, and selection, yet they often treat ideation as operating within relatively stable representational spaces. Systemic design methodologies, in turn, organize the conditions around ideation, but they less often specify the developmental structure through which intervention candidates are generated, stabilized, revised, and reorganized while designers are still differentiating the task environment. The gap is therefore not simply methodological. It concerns the limited specification of how ideation remains developmentally viable when designers must construct interventions within systemic complexity.

The present paper responds to this gap by proposing a naturalistic framework of ideation within the I–C paradigm, with IDEAS as its methodological architecture for systemic design. The value of this relation is that IDEAS does not stand apart from the developmental theory of learning that grounds it; it makes that theory operational for systemic design. Creative ideation is therefore not treated as an isolated mental operation or as a phase within systemic thinking, but as a self-directed learning and developmental process through which the thinker engages a complex task environment and progressively constructs the conditions under which intervention opportunities can become both novel and appropriate. This account is needed because both sides of the design relation are level sensitive: creative knowing develops through constructed levels of organization, while complex sociotechnical environments are organized through layered relations among purposes, constraints, interactions, mechanisms, and temporal horizons. IDEAS is the methodological expression of this self-directed developmental account, supporting designers in navigating exploratory processes across increasing levels of systemic complexity, where novelty depends on the reorganization of both intervention candidates and the conditions that make them viable.

This framework offers several concrete advantages. First, it explains why systemic ideation cannot be evaluated only by the final candidate, because the developmental pathway through which the candidate is constructed is itself part of what must be understood. Second, it distinguishes different kinds of ideation difficulty: a candidate may fail because it cannot be stabilized, because the reference values guiding it are insufficiently specified, or because higher-level development exposes missing lower-level supports. Third, it explains why design challenges must remain revisable, since emerging candidates can reveal dependencies and conditions that were not visible when the challenge was first formulated. Fourth, it makes systemic ideation researchable, because each of these functions can be examined as part of a developmental process rather than left inside an opaque creative moment.

The broader payoff is that systemic ideation becomes observable, refinable, and testable, with implications for teaching and method development. Once the functions that sustain ideation are specified at the architectural level, they can be elaborated into lower-level methods, tools, and instructional supports for different domains of exploration. They can also be examined empirically, because the framework identifies what must be observed: how designers construct intervention candidates, how they stabilize partial coherence, how they revise reference values and design challenges, and how they rebuild missing supports when higher-level development exposes unmet conditions. In this way, the Scaffold creates a shared basis for methodological development, domain-specific adaptation, pedagogical use, and empirical research, allowing progress in theory and practice to inform one another.

Overall, the IDEA Design Scaffold contributes a methodological architecture for functional ideation in systemic design by grounding method in a naturalistic account of creative development. Its main contribution is to shift systemic ideation from the generation of alternatives to the developmental construction of intervention pathways. This shift gives systemic design a way to explain, support, and study how ideas become novel, appropriate, and viable within complex task environments.

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