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Designing for Productive Misinterpretation: Sketch as a Creative Language and a Model for AI-Supported Ideation (Work-in-Progress)

Dr. Tracy Anne Hammond, Texas A&M University

Dr. Tracy Anne Hammond is a Professor of Computer Science and Engineering at Texas A&M University and Director of the Sketch Recognition Lab. She earned her Ph.D. in Electrical Engineering and Computer Science from the MIT Computer Science and Artificial Intelligence Laboratory at Massachusetts Institute of Technology, along with additional degrees from Columbia University in computer science, mathematics, applied physics, and anthropology.

Her research focuses on artificial intelligence, sketch recognition, intelligent user interfaces, haptics, and engineering education, with applications in education, health, accessibility, and related domains. She contributes to research, teaching, and professional service in AI and engineering education, with an emphasis on responsible and inclusive design.

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Abstract

This Methods/Theory Work-in-Progress (WIP) paper examines how computational tools for engineering and design, while optimized for efficiency and convergence, can inadvertently constrain early-stage ideation where creativity depends on ambiguity and reinterpretation. Drawing on research in design cognition and external representations, we frame sketching as a creative language that supports thinking through incomplete and evolving representations. We introduce a conceptual framework of productive misinterpretation, defining it as an interpretive dynamic through which ideas evolve when representations are reinterpreted rather than prematurely stabilized. The framework distinguishes productive from degenerative misinterpretation and proposes design principles for ideation-supporting systems, including preserving ambiguity, delaying stabilization, enabling reinterpretation, and maintaining user agency. We then examine implications for AI-supported ideation, arguing that generative systems should function as sensemaking partners that sustain interpretive exploration rather than as tools that collapse possibilities through single convergent outputs. Finally, we outline a research trajectory for operationalizing misinterpretation episodes through interaction data and exploring implications for creativity-supporting technologies, assessment, and learning analytics.

Introduction and Motivation

This Methods/Theory Work-in-Progress (WIP) paper proposes a conceptual framework for designing AI-supported ideation tools grounded in sketch-based creative cognition. Contemporary computational tools are largely designed to optimize for efficiency, correctness, and speed. In engineering and design contexts, these tools are highly effective at helping users converge on stable solutions or artifacts. However, decades of research on design cognition emphasize that early-stage ideation depends on divergent exploration, reinterpretation, and delayed commitment rather than rapid convergence [1–3]. When tools prioritize precision and completion too early, they risk constraining the exploratory processes that generate novel ideas.

Sketching occupies a fundamentally different role in human cognition. Engineers, designers, and scientists routinely sketch not to produce finished representations, but to think through emerging ideas [2, 4]. Sketches function as external representations that support reflection-in-action, allowing ideas to evolve through cycles of reinterpretation and reframing [4, 5]. Their power lies in their incompleteness: sketches are intentionally ambiguous, provisional, and open to multiple interpretations. This interpretive flexibility enables what design researchers describe as co-evolution between problem framing and solution generation, a process central to creative reasoning [6]. This co-evolution is not a linear progression but a recursive process in which emerging representations reshape both the problem and the solution space. Sketching supports this dynamic by allowing partial ideas to be externalized and revisited, enabling designers to engage in iterative cycles of framing, testing, and reinterpretation.

In contrast, most computational systems treat ambiguity as a problem to be resolved. Sketch recognition tools often infer a single intended object or diagram, while generative AI systems produce coherent, highly resolved outputs that encourage evaluation rather than reinterpretation. While effective for production tasks, these approaches can prematurely collapse the interpretive space that supports creative exploration [7, 8]. Because creative thinking depends on maintaining multiple possibilities and resisting premature closure [9, 10], this mismatch motivates a different design stance.

This work-in-progress paper argues for designing for productive misinterpretation. Rather than eliminating ambiguity, ideation-supporting tools should preserve and leverage it as a generative resource. We propose that sketching can be understood as a creative language and that this language provides a model for AI-supported ideation tools. This perspective is particularly relevant in engineering education, where early-stage design learning often emphasizes solution correctness over exploratory reasoning, potentially limiting opportunities for students to engage in the iterative reinterpretation processes that underlie creative expertise.

Sketch as a Creative Language

Sketching is often described as preliminary, yet this understates its cognitive role. In practice, sketches function as a pre-formal representational language that supports thinking through representation rather than merely communicating a finished idea. Unlike formal notations, sketches are intentionally underspecified, allowing meaning to remain fluid [5, 11].

A defining feature of sketching is its susceptibility to reinterpretation, including reinterpretation by its creator. Rather than hindering creativity, this misalignment between intent and representation often generates insight, as the sketch acts as a reflective partner that pushes back on the original idea [4]. From a dialectical perspective, sketching unfolds as a cycle in which an initial idea is externalized, destabilized, and transformed through synthesis [1, 3]. This perspective aligns with prior work that frames sketching as a dialectical process in which meaning emerges through iterative tension between representation and interpretation [12]. Crucially, this process depends on delaying resolution. This delay is not simply a lack of precision, but a functional property that enables multiple interpretations to remain active. By resisting early commitment, sketches allow designers to move fluidly between alternatives, supporting a form of reasoning that is exploratory rather than confirmatory. In this way, sketching facilitates the emergence of ideas that might not arise through more formal or constrained representations.

This dynamic distinguishes sketching from most computational systems, which are designed to minimize ambiguity. Sketching supports exploration by allowing interpretations to coexist long enough for new ideas to emerge. Misinterpretation thus functions as a mechanism through which representations evolve. This perspective suggests that sketches function not only as representations of ideas, but as mechanisms for generating them. By externalizing partial and evolving structures, sketching enables designers to engage with ideas that are not yet fully formed, supporting a mode of reasoning that differs fundamentally from working with complete or formalized representations.

Designing for Productive Misinterpretation

If sketching is a creative language, misinterpretation becomes a phenomenon that can be intentionally structured. Unlike prior work that treats ambiguity as a static property, this framework conceptualizes misinterpretation as a dynamic, episode-based process. We define productive misinterpretation as an interactional event in which a representation is interpreted differently from its prior intended meaning and leads to a meaningful transformation of the idea. Such episodes are not isolated events but unfold over short sequences of interaction, in which a representation is produced, reinterpreted, and modified. Treating misinterpretation as an episode shifts the focus from static ambiguity to dynamic processes of meaning-making that can be observed and eventually analyzed.

Productive vs. Degenerative Misinterpretation. Productive misinterpretation introduces interpretive tension without eliminating user agency. It occurs when a representation challenges intent while still allowing meaningful response [4]. Degenerative misinterpretation, by contrast, overwhelms the user's ability to reason with the representation.

Example. A designer sketching a structural support may draw a diagonal line intended as reinforcement. Upon viewing the sketch, the line is reinterpreted as suggesting a cable system rather than a rigid beam. This reinterpretation introduces a new structural concept, prompting exploration of alternative strategies. In contrast, if the representation were automatically corrected, the opportunity for reinterpretation would be lost. As the designer explores this reinterpretation, the representation itself may be modified to reflect new structural assumptions, leading to further reinterpretations in subsequent iterations. In this way, the initial misinterpretation does not simply introduce an alternative idea, but initiates a sequence of transformations through which the design space is expanded. By contrast, systems that prematurely resolve the representation would truncate this sequence, limiting the opportunity for such emergent exploration.

Design Principles.

1. Preserve ambiguity in early stages.
2. Delay stabilization.
3. Support reinterpretation and revision.
4. Maintain user agency [13].

Importantly, this framing suggests that misinterpretation can be studied through observable interaction patterns. Episodes may be reflected in pauses preceding revision, reorganization of representations, or shifts in structure following reinterpretation, providing a basis for future operationalization. Together, these principles define a design space in which misinterpretation is not eliminated, but structured as a generative component of ideation. This framing extends prior work on ambiguity as a design resource by shifting from properties of representations to processes of interaction. Rather than treating ambiguity as a static feature to be preserved or resolved, productive misinterpretation is conceptualized as an episode that unfolds over time through cycles of interpretation, disruption, and revision. This shift enables ambiguity to be studied not only as a design principle, but as an observable and potentially measurable aspect of creative cognition, providing a foundation for connecting interaction data with learning and ideation processes.

Implications for AI-Supported Ideation

The framework suggests rethinking AI systems as sensemaking partners rather than answer generators. Generative systems often converge on a single output, limiting reinterpretation. AI-supported tools can instead sustain exploration by maintaining multiple representations, surfacing alternatives, and introducing controlled perturbations [8, 14]. For example, systems might present multiple plausible interpretations (multi-hypothesis generation), respond incrementally (turn-taking), or support reversible transformations that allow users to explore and undo reinterpretations (repair). To illustrate, consider an AI-supported sketching environment in which a user draws a partial structural form. Rather than resolving the sketch into a single interpreted object (e.g., beam, truss, or frame), the system could present multiple concurrent interpretations layered over the original representation. For example, a diagonal line might be interpreted simultaneously as a rigid support, a tension cable, or a force vector, each with lightweight visual augmentation. The user could interact with these interpretations through selective emphasis, toggling, or incremental refinement, allowing exploration without committing to a single representation. Importantly, these interpretations would remain provisional and reversible, preserving the ambiguity necessary for continued ideation.

Such systems would also shift from one-shot generation toward turn-based interaction. Instead of producing a complete solution in response to a prompt, the AI could introduce small perturbations or alternative framings in response to user actions, functioning as a collaborator in an ongoing interpretive process. This interaction model aligns more closely with the iterative cycles observed in sketch-based reasoning, where meaning emerges through sequences of representation, reinterpretation, and revision rather than through immediate resolution.

These design implications suggest a broader shift in how AI systems are evaluated in creative contexts. Rather than measuring success solely in terms of output quality or correctness, systems designed for ideation must also be assessed based on how they support exploration, reinterpretation, and user agency over time. This perspective reframes AI not as a tool for accelerating completion, but as a participant in an ongoing interpretive process, where value emerges through interaction rather than resolution. These interaction patterns do not simply generate alternatives, but structure the timing and reversibility of interpretation, allowing users to engage in cycles of exploration without premature commitment.

Work-in-Progress Trajectory and Future Directions

This work presents a conceptual framework for studying misinterpretation as a generative mechanism in creative cognition. Rather than assuming direct correspondence between behavior and cognition, this framework treats such mappings as hypotheses requiring validation. This approach emphasizes the need to connect quantitative interaction data with qualitative accounts of reasoning, ensuring that interpretations of behavior remain grounded in users' meaning-making processes.

Operationalizing misinterpretation as an observable construct requires identifying measurable indicators within interaction data. In sketch-based environments, this may include temporal markers such as pauses preceding revision, rapid sequences of modification following a period of inspection, or divergence between successive representations. These indicators can be complemented by structural analyses of sketch evolution, including the addition, deletion, or reorganization of elements across iterations. At the interaction level, episodes of misinterpretation may be inferred when a representation is reworked in a way that reflects a shift in underlying conceptual framing rather than incremental refinement.

To validate these interpretations, future studies will employ mixed-methods approaches that combine interaction trace data with qualitative accounts of user reasoning. Think-aloud protocols, retrospective interviews, and artifact analysis can provide insight into how users interpret and reinterpret representations over time. Rather than assuming a direct mapping between behavior and cognition, this approach treats observed patterns as hypotheses that must be triangulated across data sources. This methodological framing supports a more robust connection between observable interaction and the interpretive processes central to creative cognition.

More broadly, this perspective has implications for how creativity is supported and evaluated in engineering education. By emphasizing reinterpretation as a central mechanism of idea development, it suggests a shift from viewing design as a process of converging on correct solutions toward understanding it as an evolving interaction between representation and reasoning. This shift may influence how instructors scaffold ideation, how tools provide feedback, and how learning outcomes are conceptualized in design-oriented courses. Future work will identify behavioral indicators of misinterpretation episodes, including pauses preceding revision, reorganization of representations, and shifts following reinterpretation. These constructs motivate AI-supported environments that preserve interpretive space. Pilot studies will examine how such systems influence idea evolution and reflective synthesis while addressing ethical considerations including transparency, consent, and responsible data use.

This framework also has implications for assessment. If creative thinking depends on cycles of reinterpretation and instability, evaluation must extend beyond outcome-based measures to capture process-level indicators of exploration and synthesis. This shift challenges traditional assessment models that privilege correctness and completion, suggesting instead the need for approaches that account for how ideas evolve over time. Such approaches may include analyzing interaction traces, reflective artifacts, or iterative design changes to better understand the role of reinterpretation in learning and creative development.

References

[1] N. Cross, "Design cognition: Results from protocol and other empirical studies of design activity," in *Design Knowing and Learning: Cognition in Design Education*. Elsevier, 2001.

[2] V. Goel, *Sketches of Thought*. MIT Press, 1995.

[3] G. Goldschmidt, "The dialectics of sketching," *Creativity Research Journal*, vol. 4, no. 2, pp. 123–143, 1991.

[4] D. A. Schön, *The Reflective Practitioner*. Basic Books, 1983.

[5] D. Kirsh, "Thinking with external representations," *AI & Society*, vol. 25, no. 4, pp. 441–454, 2010.

[6] K. Dorst and N. Cross, "Creativity in the design process: Co-evolution of problem–solution," *Design Studies*, vol. 22, no. 5, pp. 425–437, 2001.

[7] W. W. Gaver, J. Beaver, and S. Benford, "Ambiguity as a resource for design," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI)*. ACM, 2003, pp. 233–240.

[8] S. Amershi, D. Weld, M. Vorvoreanu *et al.*, "Guidelines for human-ai interaction," in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI)*. ACM, 2019.

[9] J. P. Guilford, *The Nature of Human Intelligence*. New York: McGraw-Hill, 1967.

[10] M. A. Runco and G. J. Jaeger, "The standard definition of creativity," *Creativity Research Journal*, vol. 24, no. 1, pp. 92–96, 2012.

[11] J. Zhang and D. A. Norman, "Representations in distributed cognitive tasks," *Cognitive Science*, vol. 18, no. 1, pp. 87–122, 1994.

[12] T. Hammond, "Dialectical creativity: Sketch-negate-create," in *Studying Visual and Spatial Reasoning for Design Creativity*, J. S. Gero, Ed. Dordrecht: Springer Netherlands, 2015, pp. 91–108.

[13] D. A. Norman, *The Design of Everyday Things*, revised and expanded ed. Basic Books, 2013.

[14] B. Shneiderman, *Human-Centered AI*. Oxford University Press, 2022.