Tools for Creative Cognition: Generative AI in Design Thinking

Peter Dalsgaard
dalsgaard@cavi.au.dk
Aarhus University
Aarhus, Denmark

Abstract

This position paper examines Generative AI through the pragmatist concept of *instruments of inquiry*, ie. tools that shape and guide thinking in creative processes such as design. The focus is on how Generative AI influences five dimensions of inquiry: *perception, conception, externalisation, knowing-through-action*, and *mediation*.

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**; • **Empirical studies in HCI**;

Keywords

Creativity, Design, Creativity Support Tools, Generative AI

ACM Reference Format:
Peter Dalsgaard. 2018. Tools for Creative Cognition: Generative AI in Design Thinking. In *Proceedings of April 26, 2025 (ACM CHI'25 Tools for Thought Workshop).* ACM, New York, NY, USA, 4 pages. https://doi.org/XXXXXXX.XXXXXXX

1 Introduction

The field of design is constantly evolving, with new technologies emerging that have the potential to reshape design practice. Among these, generative artificial intelligence (GenAI) stands out as having particularly transformative potential, offering novel ways of creating and exploring design concepts. While designers routinely use a range of tools in their work, there is a lack of comprehensive frameworks for understanding how and why these tools work. This gap in understanding becomes especially critical when considering the integration of complex technologies such as GenAI into the design process. This position paper addresses this gap by exploring how we can understand GenAI through the lens of pragmatist philosophy, a perspective that emphasises active engagement with the world, the role of experience in shaping knowledge, and the inherent interconnectedness of thought and action. In light of this workshop's focus on tools of thought, I will specifically expand upon the concept of '*instruments of inquiry*' [4], ie. tools that influence how designers perceive problems, conceive solutions, externalise ideas, learn through action, and engage in dialogue and coordination. The original motivation for developing the instruments of inquiry concept came from the realization that tools play a crucial role in design practice, and that a big part of design competence seems to stem from how designers build up and dynamically use these tools in various configurations, depending on the design problems they face. GenAI tools are being developed and deployed in design practice at breakneck speed as a new form of creativity-support tools [6][7] that are arguably qualitatively different than most prior tools. Not just in their capabilities for generate output that can be near-impossible to distinguish from human creations, but also because of how they might transform how we think with and through them in creative tasks. My aim with bringing the instruments of inquiry perspective to bear on GenAI is to move beyond a functional perspective on GenAI and a focus the outputs it can generate, and instead examine it as a '*tool for thought*' that can - for better or worse - shape designerly thinking. Through this the pragmatist lens, I will thus examine the implications of GenAI as an integral part of a reflective, iterative, and explorative design process.

ACM CHI'25 Tools for Thought Workshop,

ACM ISBN 978-x-xxxx-xxxx-x/YYYY/MM
https://doi.org/XXXXXXX.XXXXXXX

2 Pragmatism and Instruments of Inquiry

Pragmatism, particularly the Deweyan strand [5], offers a rich conceptual vocabulary for exploring the nature of design as a form of inquiry. At its core, pragmatism posits that knowledge is not a passive reception of facts, but rather an active and ongoing process of engagement with the world. This perspective resonates deeply with the practice of design, which is fundamentally about *transforming problematic situations* into more desirable ones through a process of exploration and intervention.In this view, design is not simply about applying pre-existing knowledge or methods; it is *a form of inquiry in itself.* Building on Dewey, Scön has shown how designers are constantly engaged in a process of making sense of complex and often ambiguous situations [10]. This involves identifying and framing problems, generating and testing potential solutions, and iteratively refining these solutions through a continuous cycle of action and reflection. This process is not purely intramental; it is deeply intertwined with the materials and environments in which designers operate. *The world becomes part of the cognitive process.* [3]

This interaction is mediated by what Dewey called '*technology*,' which, in this context, is not just about digital tools but rather refers to the entire range of resources and instruments that we use to make sense of the world. This includes physical materials, sketching tools, prototypes, language, and of course, digital technologies like GenAI. Technology, in this broad understanding, is *always already present*, shaping our perceptions and framing our experiences. It is not a neutral tool, but rather an active agent in the process of inquiry. It both enables and constrains our actions [8]. This dual nature of technology is crucial to understanding its role in design and the basis for my conceptualization of *instruments of inquiry* [4]. Instruments of inquiry are defined as tools that scaffold the process of inquiry. These instruments influence how designers perceive problems, conceive solutions, externalise ideas, learn through action, and engage in dialogue and coordination. Using instruments of inquiry, designers constantly test and refine their ideas through interaction with the material and social environment, and as designers master these instruments, they develop a repertoire of knowledge and skills that becomes integral to their practice. This understanding of the designer as a reflective practitioner, constantly learning through doing, is a core tenet of the pragmatist view. The framework of instruments of inquiry includes five key qualities: *perception, conception, externalisation, knowing-through-action,* and *mediation.* In the following, I will examine these five qualities in turn as they apply to GenAI.

3 GenAI and Perception in Design

The concept of perception, within the framework of instruments of inquiry, refers to how tools enable designers to see and understand a design situation, while also inherently obscuring other aspects. It's about recognising that instruments aren't neutral; they actively shape what designers perceive and how they interpret it. When considering GenAI as a design instrument, it's crucial to examine how it alters the designer's perception of the design space and the problems within it.

GenAI exerts a notable influence on how designers perceive the design space by simultaneously broadening and constraining what they see. On one hand, it can generate multiple visual styles or concepts that the designer might not have arrived at independently. Such outputs illuminate novel directions, prompting a reevaluation of initial assumptions. On the other hand, focusing too intently on the AI's suggestions can yield a form of tunnel vision; instead of engaging deeply with the problem, the designer may end up merely filtering or tweaking the generated proposals. This shift can obscure certain facets of the situation, undercutting the open-ended exploration and user-centric awareness that typically drive meaningful design decisions.

The instruments designers use invariably shape how they frame their tasks, a dynamic that becomes particularly evident with GenAI. Trained on specific data sets and styles, an AI model may bias the design space by gravitating toward familiar patterns. A tool that was developed on predominantly Western user-interface examples, for instance, might propagate those conventions even when they're unsuitable for a different cultural context. If the designer reflexively adopts the AI's direction, key insights—particularly around lived user experiences—risk being overlooked. Over time, learning to spot these biases and question the AI's suggestions becomes integral to mastering the technology. Just as traditional tools require a skilled hand to unlock their full potential, GenAI demands critical awareness to discern which outputs expand the design space and which introduce unhelpful constraints [1].

Another consideration is how GenAI redirects a designer's attention. Tools that propose early-stage sketches or prototypes might tempt teams to skip the messy, conceptual groundwork. Designers risk devoting themselves to refining polished outputs instead of grappling with an ill-defined problem's deeper layers, thereby altering the focus of inquiry from the problem's core to whatever the tool readily produces. This can mask the complexity that fuels genuinely innovative work. Much of design hinges on deliberate attention to subtleties; by ceding the initial framing to AI, designers may unintentionally limit their creative palette.

Ultimately, learning to "read" and "sculpt" GenAI outputs is key to ensuring that perception remains constructive. When designers iteratively manipulate an AI-generated concept—adding constraints here, removing parameters there—they see changes that spark fresh ideas, steadily refining their understanding of both the problem and the emerging solution. This interactive process, supported by the ability to "look at it" and respond in real time, exemplifies how GenAI can serve as a productive partner in creative thinking. It can become a catalyst for deeper engagement, provided designers maintain a watchful, critical stance toward how the technology frames, obscures, and reveals the design space.

4 GenAI and Conception in Design

Conception, in the context of design, refers to the crucial phase where designers understand and articulate design problems, and subsequently form and revise hypotheses about potential solutions. GenAI offers designers a new way to conceive and frame projects, particularly by helping them articulate the often ambiguous challenges that arise in complex or "wicked" problem spaces [2]. When a team encounters a knotty design scenario—say, improving an urban transport system with numerous stakeholders—they can prompt an AI model to generate alternate visions of possible layouts, policy interventions, or passenger experiences. Seeing these multiple representations can reveal facets of the problem that wouldn't surface through standard brainstorming alone. By iterating on AI-generated ideas, designers gradually refine how they see the problem's boundaries, constraints, and potential solutions.

Once a clearer sense of the challenge has emerged, GenAI can also foster the rapid generation and testing of hypotheses. In a product design context, for instance, a group might start with a simple prompt describing a new kitchen appliance concept. The AI responds with a range of possible configurations, some of which stray beyond the designers' usual thinking. These unexpected solutions become starting points for further refinement: a prompt is adjusted, new outputs appear, and the design direction evolves in real time. This cyclical process helps designers compare and contrast alternatives without committing extensive resources to each one, paving the way for a more dynamic, hypothesis-driven approach to creativity.

Using GenAI as a tool for conceptual exploration means designers can turn abstract notions into tangible artifacts, which then serve as conversation pieces for teams and stakeholders. If a service designer imagines a future healthcare app, the AI can quickly generate interface variations or suggest behind-the-scenes features. Those glimpses of what might be possible help the team identify which aspects merit closer scrutiny, prompting them to experiment with additional constraints or to adjust the training data for a more focused exploration. In doing so, GenAI not only expands the creative range but also provides a direct route to externalising early-stage ideas—an essential step in a reflective design process[10].

Despite these advantages, GenAI carries inherent constraints that shape what it can—and cannot—produce. The biases and blind spots in the training data may limit the scope of solutions, echoing or even reinforcing existing patterns. Designers who understand how an AI system was trained can make conscious choices to counteract or exploit such patterns, effectively using limitations as a springboard for more inventive outcomes. By maintaining awareness of the tool's strengths and shortcomings, GenAI has the potential to amplify designers' capacity to understand, articulate, and tackle design problems.

5 GenAI and Externalisation in Design

Externalisation, within the design process, is the act of making ideas tangible and part of the world, creating a crucial space for reflection and development. Instruments of inquiry facilitate this process by enabling designers to move concepts from the abstract realm of thought into concrete forms that can be manipulated, evaluated and refined. GenAI has introduced new possibilities for externalisation in design by translating abstract ideas into tangible expressions at an accelerated pace. Rather than relying on time-intensive prototypes or detailed sketches, designers can now use GenAI to produce a variety of images, simulations, or conceptual models that serve as immediate representations of ideas. This process can uncover dimensions of a concept that might remain hidden if designers only reasoned about them internally. For example, a team developing an innovative piece of wearable technology could feed conceptual prompts into a generative system and instantly obtain multiple visualisations, ranging from minimalist designs to experimental forms, each of which can spark further debate and reflection.

The moment these AI-generated representations become visible or interactive, they allow designers to engage in what Schön termed "reflection-in-action." [10] By continually adjusting inputs and reviewing the outputs, they engage in a conversation with the design material. Sometimes the results confirm initial assumptions; at other times, they prompt a rethinking of fundamental design choices. This quick feedback loop makes the design process more dynamic: instead of a single, linear progression, designers can branch out, test, discard, and refine multiple concepts in parallel. Over successive iterations, they begin to see patterns or potential pitfalls, discovering new directions in the process.

A key advantage of GenAI lies in its capacity to *extend the domain of externalisation beyond static artifacts*. Designers can rapidly set up interactive scenarios or generate entire simulated environments to explore user experiences that were once difficult to prototype. Such simulations accelerate understanding of how users might engage with a product or service, revealing opportunities for improvement at an early stage. This approach also acts as a form of *cognitive offloading*, freeing designers from the task of mentally juggling complex details. By delegating some of the workload to AI, designers can focus on evaluating and interpreting outcomes. At the same time, the process of bringing a rough idea into a concrete, AI-generated form offers a "thing to think with" that stimulates new questions and insights.

Yet these benefits do not emerge from the technology alone; they hinge on the ways in which designers orchestrate and interpret what the AI produces. Mastery of GenAI thus becomes a core skill. Designers who understand how different prompts influence outputs are better positioned to spot interesting anomalies, refine promising leads, and harness unexpected results to their advantage.

6 GenAI and Knowing-Through-Action in Design

Knowing-through-action describes how new ideas emerge when designers learn by actively working with a tool or material (Schön, 1983). In the context of GenAI, this view underscores how interaction with algorithms can shape both the direction of design work and the designer's growing understanding of possibilities.

GenAI offers a compelling lens through which to understand "knowing-through-action," a process in which new ideas emerge as designers learn by actively working with tools in real time. From a pragmatist perspective, this means that thinking and doing are intertwined in a reciprocal process of experimentation and reflection[3]. By interacting with the technology—prompting, adjusting, and critiquing outputs—designers gain insights that might not otherwise surface. For instance, a team developing a visual brand identity could explore various styles and color palettes by engaging a text-to-image model, viewing each AI-generated result as both a potential solution and a prompt for further ideation. This back-and-forth cycle highlights the mutual shaping of design intentions (thinking) and the tangible artifacts that come from using GenAI (doing). In some cases, designers may start with only a loose concept, relying on each iteration to guide them toward a more specific vision. This open-ended engagement invites serendipitous discoveries; the AI's unexpected suggestions can reveal unexamined trajectories that expand the boundaries of a project. Each GenAI output can trigger new hypotheses that change how the designer frames the task at hand. If the model generates an unexpected layout for a smartphone application, the designer might decide to test alternative interface flows, leading to further outputs that inform subsequent revisions. This back-and-forth exchange exemplifies a cycle in which doing (prompting GenAI) and thinking (interpreting its responses) are closely interconnected.

The process can also facilitate *epistemic actions*[9], as GenAI reveals information that might be otherwise hidden or difficult to compute mentally. Designers testing layout variations for an application's interface could uncover nuanced visual hierarchies simply by repeatedly prompting and observing how the model interprets their input constraints. This fosters an environment akin to virtual experimentation, wherein new concepts can be tried out and refined with minimal resource commitments. As designers grow increasingly familiar with GenAI, they develop tacit knowledge about how prompts and outputs interact—sharpening their ability to spot patterns, recognize the tool's biases, and steer the AI's generative potential. Yet while GenAI can serve as a powerful co-creator, it poses certain challenges. Overreliance on algorithmic suggestions risks diluting human-driven creativity, and the patterns that surface in AI outputs may unintentionally entrench existing biases (Broussard, 2018). These tensions underscore the need for a reflective stance: designers who treat GenAI as one influence among many, rather than as a default solution engine, are in a better position to gain from using it without sacrificing critical judgment or design agency.

7 GenAI and Mediation in Design

Mediation, in the context of design, refers to the way that instruments or tools facilitate connections and coordination between the various entities involved in a design situation. These entities include the designers, other stakeholders, the design artefacts themselves, and the broader context in which the design process unfolds.

Mediation in design captures how various tools facilitate the coordination and understanding among all participants in a creative process. These participants might include designers, stakeholders, end users, and the artifacts themselves. Each instrument of inquiry effectively becomes a shared reference point, allowing diverse perspectives to converge around tangible representations of ideas or problems. When, for example, a distributed team employs a digital brainstorming platform, sketches and prototypes can be uploaded, annotated, and iterated upon in real time, turning abstract discussions into designs that everyone can see, manipulate, and critique.

This dynamic is often enhanced by '*boundary objects*', artifacts that occupy a middle ground between different fields or specializations[11]. GenAI can serve as such a boundary object by swiftly generating concepts—sketches of hypothetical interfaces or quick layouts for a proposed building façade—that instantly communicate a variety of possibilities. These AI-generated outputs become focal points for conversation, giving multiple stakeholders something concrete to agree or disagree on. As stakeholders debate the strengths and limitations of these representations, the dialogue drives a collective shaping of the final outcome.

Another function of mediation is to coordinate actions toward a shared goal. In a scenario where design teams and clients convene for a creative workshop, GenAI might generate prompts or idea variations that spark debate and discussion. The act of responding to these prompts both clarifies each stakeholder's concerns and allows for alignment of expectations. Instead of abstractly stating, "We need a user-friendly interface," participants can interact with actual AI-provided mock-ups, iterating on them until a clearer sense of "user-friendly" emerges. Through these repeated negotiations, the AI artifacts guide the group's progression from broad aspirations to more precise objectives.

These tools do more than just streamline communication. They become evolving components of the process, changing and adapting as stakeholders refine inputs and interpretations. For instance, a service design team might begin with loose prompts to generate customer journey illustrations. Over time, these initial outputs accumulate annotations and revisions, evolving into more detailed diagrams reflecting the group's growing understanding. This reshaping of artifacts mirrors the incremental nature of design, where meaning and function emerge—and often shift—through ongoing use.

In this sense, mediation is as much about how artifacts foster trust, dialogue, and shared purpose as it is about producing a final product. It is within the interactions around these representations that knowledge is constructed, misunderstandings surface, and consensus forms. By presenting content that can be experienced and manipulated by all involved, GenAI and other design instruments help bridge differing expertise, disciplinary languages, or even cultural backgrounds.

8 Conclusions and Considerations

In the most optimistic of views, GenAI may lead to a more exploratory, dialogical, and adaptive form of design practice where human expertise and computational outputs merge into a dynamic form of inquiry. Examining GenAI through the pragmatist lens of instruments of inquiry prompts us to see it as a tool that not only accelerates routine tasks but also reshapes how designers perceive, conceive, externalise, learn through action, and coordinate design efforts. This dual role—being both catalyst and constraint—highlights GenAI's capacity to expand creative horizons while risking tunnel vision if used uncritically.

The reflective, iterative, and collaborative ethos of pragmatist design theory is well matched by GenAI's aptitude for rapid idea generation and real-time feedback. But unlocking its full value requires a critical and knowledgeable stance: designers who understand how to guide the AI, interpret results, and build on unexpected outcomes are more likely to gain fresh insights that foster innovation and meaningful solutions. Conversely, overreliance on GenAI can displace crucial exploratory steps and narrow designers' creative exploration. Maintaining a balanced approach that values emergent human insights alongside algorithmic possibilities is crucial.

In practical terms, this means fostering skill development, establishing transparent workflows, and cultivating design cultures that welcome generative tools while holding them accountable. It also calls for continued research on biases, intellectual property, and user-centric considerations to prevent unintended consequences.

Acknowledgments

This research is made possible by the Independent Ressearch Fund Denmark, grant 0132-00111B: Managing Ideas in Creative Work. ChatGPT 4o was employed for language and grammar revisions .

References

[1] Michael Mose Biskjaer, Peter Dalsgaard, and Kim Halskov. 2014. A constraint-based understanding of design spaces. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (Vancouver, BC, Canada) *(DIS '14)*. Association for Computing Machinery, New York, NY, USA, 453–462. doi:10.1145/2598510.2598533
[2] Richard Buchanan. 1992. Wicked Problems in Design Thinking. *Design Issues* 8, 2 (1992), 5–21.
[3] Peter Dalsgaard. 2014. Pragmatism and Design Thinking. *International Journal of Design* 8, 1 (2014), 143–155.
[4] Peter Dalsgaard. 2017. Instruments of Inquiry: Understanding the Nature and Role of Tools in Design. *International Journal of Design* 11, 1 (2017), 21–33.
[5] John Dewey. 1938. *Logic: The Theory of Inquiry.* Henry Holt, New York.
[6] Jonas Frich, Lindsay MacDonald Vermeulen, Christian Remy, Michael Mose Biskjaer, and Peter Dalsgaard. 2019. Mapping the Landscape of Creativity Support Tools in HCI. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) *(CHI '19)*. Association for Computing Machinery, New York, NY, USA, 1–18. doi:10.1145/3290605.3300619
[7] Jonas Frich, Michael Mose Biskjaer, and Peter Dalsgaard. 2018. Twenty Years of Creativity Research in Human-Computer Interaction: Current State and Future Directions. In *Proceedings of the 2018 Designing Interactive Systems Conference* (Hong Kong, China) *(DIS '18)*. Association for Computing Machinery, New York, NY, USA, 1235–1257. doi:10.1145/3196709.3196732
[8] Larry A. Hickman. 1990. *John Dewey's Pragmatic Technology.* Indiana University Press, Bloomington, IN.
[9] David Kirsch and Paul Maglio. 1994. On Distinguishing Epistemic from Pragmatic Action. *Cognitive Science* 18, 4 (1994), 513–549.
[10] Donald A. Schön. 1983. *The Reflective Practitioner: How Professionals Think in Action.* Basic Books.
[11] Susan Leigh Star and James R. Griesemer. 1989. Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* 19, 3 (1989), 387–420.

Received 10 April 2025; revised 10 April 2025; accepted 10 April 2025