Minds in the Making: Cognitive Science and Design Thinking

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Keywords: design; learning; problem-solving; communication; creativity; human-computer interaction

Design is the transformation of existing conditions into preferred ones.
– Herbert Simon

Overview and Motivation

All around us are traces of human design, from color-coded subway maps that facilitate navigation to furniture that balances form and function. The human capacity for creation has long fascinated cognitive scientists. Early studies of innovation highlighted the role of problem-solving, elucidating the roles of search and heuristics (Simon, 1996; Newell, 1972). Research on object perception and tool use enhanced our understanding of how humans interact with and manipulate their environment (Gibson, 1977; Norman, 1999). Subsequently, research in the visual and spatial domains uncovered key abstractions supporting reasoning, communication, and expression through visual forms, such as mental models, diagrams, and spatial analogies (Hegarty, 2011; Tversky, 2010; Goel, 1995).

Despite long-standing interest, a unifying theory of how humans reason about design remains elusive. A particular challenge stems from the ill-structured nature of design goals (e.g., to create engaging lessons or *elegant* graphics). Solving "wicked" design problems (Buchanan, 1992) often requires iterative refinement and strategies that may well diverge from traditional models of problem-solving predicated on well-specified end states (Dorst & Cross, 2001; Goel & Pirolli, 1992). How can we make progress towards more unified theories of the human capacity to shape both their own experiences and those of others?

Recent advances across computer science, cognitive science, and education offer promising new directions. First, new technologies in computer graphics and machine learning have enabled novel ways to create and edit visual designs, especially using more expressive and semantically rich inputs such as sketches and natural language (Hertzmann, 2025). Using such tools as experimental paradigms have produced more detailed insights into how humans create and comprehend visual designs (Fan et al., 2023), including underlying neural mechanisms (Saggar et al., 2015a). Second, recent work has successfully applied computational models of inference and decision-making to understand both how designers engage in iterative problem solving (Zhao et al., 2024) and how people reason about the intents and actions leading to different design outcomes (Jara-Ettinger & Schachner, 2024). Third, large-scale interventions and collaborations with practitioners, particularly in education (Bermudez et al., 2023), have yielded empirical evidence for best practices in learner-centered design.

Given the above, now is the time to synthesize concepts, methods and models, and identify opportunities for future research. The goal of this workshop is to bring together diverse perspectives to address the full complexity of design cognition. We focus on two central questions: (1) **How do people reason about design decisions?** and (2) **How does design impact human behavior and learning?**

Approach and Schedule

We propose a hybrid workshop to make the most of the limited conference schedule. First, we will convene a series of **virtual pre-conference seminars** around four central themes: *Perception*, *Problem solving*, *Communication*, and *Learning*. These themes all represent core research areas in Cognitive Science as well as dominant spheres through which design impacts human lives. Each seminar comprises speakers from at least two disciplines (Cognitive Science, Design, Education, or Human-Computer Interaction) who will discuss how their research addresses our central questions. Invited speakers will give brief 15-minute talks before participating in a moderated discussion to identify points of overlap as well as opportunities for collaboration and innovation. These virtual events will be open to the public (registration required) and recorded.

At the main conference, we will host **in-person activities** emphasizing interaction and conversation among participants. We will begin with a **design workshop** facilitated by faculty from the Stanford Hasso Plattner Institute of Design. These hands-on and "minds-on" activities will serve not only to promote an interactive and creative attitude among participants (Saggar et al., 2015b), but crucially, will expose the fundamental concepts, decisions, and creative processes used by professional designers. Next, a **keynote talk** by Barbara Tversky will provide a broad survey of the rich intersections between cognitive science and design research to identify lessons and open questions for both fields. An in-person **poster session** will complement this by highlighting exciting new research. We plan to dedicate funds allocated to this workshop to support early career researchers through two Best Poster Awards. Finally, the workshop will conclude with a **panel discussion**, comprising a subset of invited speakers, to reflect on key insights and questions raised throughout the virtual and in-person events.

Invited Speakers

Our speakers span multiple disciplines, perspectives, and career stages. All of them share a strong background and interest in understanding the human capacity to create.

Virtual Session 1: Perception/Creativity

Aaron Hertzmann is a Principal Scientist at Adobe Research who is interested in how AI technologies reveal new insights into the nature of visual perception and aesthetics.

Manish Saggar is Associate Professor of Psychiatry & Behavioral Sciences at Stanford who investigates the neural mechanisms of creative design.

Mark Riedl (invited) is a Professor in the School of Interactive Computing at Georgia Tech who studies how people create and comprehend stories and video games.

Virtual Seminar 2: Problem-solving

Bonan Zhao is a Lecturer in Computational Cognitive Science at the University of Edinburgh who is interested in how people solve problems together.

Kelsey Allen is an Assistant Professor of Computer Science at University of British Columbia who is interested in how people make use of tools to reshape their environment.

Ranjay Krishna is an Assistant Professor of Computer Science & Engineering at University of Washington who is interested in how machines use visual artifacts to reason.

Virtual Session 3: Communication

Julian Jara-Ettinger is an Associate Professor of Psychology and Computer Science at Yale who investigates the social-physical inferences people make from the world.

Arvind Satyanarayan is an Associate Professor of Computer Science at MIT who is interested in how people design and communicate through visualizations.

C Thi. Nguyen (invited) is a Professor of Philosophy at University of Utah who examines how social structures and technologies shape how we think and what we value.

Virtual Session 4: Learning

Yasmin B. Kafai is a Professor of Learning Sciences at University of Pennsylvania who is interesting in helping students learn through computer programming and crafting.

Vanessa Bermudez is a PhD student at the UC Irvine School of Education who is interested in evaluating family- and play-based learning environments.

Julian Togelius, Associate Professor of Computer Science at NYU, works at the intersection of AI and games to examine how agents can learn to play and design better games.

In-person Workshop

Barbara Tversky is Professor of Psychology at Columbia University and Professor Emerita at Stanford. They will deliver a keynote talk on human cognition and design.

Grace Hawthorne is an entrepreneur, artist, author, and adjunct Professor at the Stanford d.school who will facilitate the in-person design workshop.

Organizers

This workshop is chaired by **Junyi Chu**, a postdoctoral researcher at Stanford, **Arnav Verma**, research staff member at Stanford, **Guy Davidson**, a PhD student at NYU, **Robbie Fraser**, a Master's student at Stanford, and **Judith Fan**, an Assistant Professor at Stanford.

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