Attention-Preserving Tangible Interfaces: Using Physicality and Materiality to Preserve Attention in the Home

Anup Sathya
University of Chicago
Chicago, Illinois, USA
anups@uchicago.edu

Ken Nakagaki
University of Chicago
Chicago, Illinois, USA
knakagaki@uchicago.edu

Abstract

Ambient interfaces and calm technology have tried to address attention concerns by operating peripherally in the background. However, as smart home devices increasingly demand attention, we propose a different approach: primary interfaces can employ "least sensing" or "sensory reduction" as attention-preserving mechanisms. Physical privacy-preserving mechanisms have become increasingly common in smart homes, from camera covers to mechanical microphone switches, giving users direct control through physical interaction. Building on this trend, this full-day studio introduces "attention-preserving tangible interfaces"—tangible interfaces that preserve attention through sensory reduction rather than peripheral operation. Through hands-on activities, participants will explore how primary interfaces might be designed to reduce sensory engagement, speculating on what attention-preserving tangible interfaces might look like in smart home contexts. This studio is particularly relevant as smart home devices proliferate and compete for attention, offering an alternative vision of technology that respects rather than demands our focus.

CCS Concepts

• **Human-centered computing** → **Human computer interaction (HCI)**; *Interaction paradigms*; Interaction design; • **Applied computing** → Consumer health.

Keywords

tangible interaction, ambient interfaces, smart homes, attention, calm computing, minimal interaction

ACM Reference Format:
Anup Sathya and Ken Nakagaki. 2026. Attention-Preserving Tangible Interfaces: Using Physicality and Materiality to Preserve Attention in the Home. In *Twentieth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '26), March 08–11, 2026, Chicago, IL, USA.* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/3731459.3779047

1 Introduction

Ambient displays [7] and calm technology [5] have tried to address concerns about attention in human-computer interaction. The Ambient Orb [7] demonstrated how subtle changes in color could convey information peripherally, while calm computing [5] proposed technologies that exist in the periphery of our attention rather than demanding it. These approaches work by operating in the background, providing information through slow, peripheral changes that don't require immediate focus or response. They respect our focus by staying out of the way, existing at the edges of our awareness.

However, as smart home devices proliferate, from voice assistants that respond to wake words to smart displays that light up with notifications and ads, they increasingly compete for our attention. Here, we understand *attention* as our limited cognitive capacity to focus on and process information, which can be disrupted by technologies that demand immediate engagement, pulling us away from other activities and creating a constant stream of interruptions in our domestic spaces. While ambient interfaces address attention by operating peripherally, we propose that primary interfaces can employ "least sensing" or "sensory reduction" as attention-preserving mechanisms. We define *least sensing* as an approach that requires minimal sensory engagement—using fewer sensory channels or less sensory information rather than demanding full attention through maximal sensory modalities. *Sensory reduction* extends this concept, proposing that interfaces can preserve attention by actively reducing the engagement ceiling, using fewer sensory channels or less sensory information. For example, an interface might use only haptic feedback instead of visual and auditory cues, or provide information through slow, minimal changes rather than immediate, attention-grabbing notifications.

Physical privacy-preserving mechanisms provide one context for understanding how tangible interfaces can address concerns about smart home technologies. From camera covers that physically block lenses to mechanical switches that disconnect microphones, these tangible mechanisms give users direct, physical control over their privacy. Research has shown that users value these physical mechanisms because they provide clear, unambiguous control that doesn't require understanding and fiddling with complex digital settings [6]. These mechanisms work by using physical affordances—sliding covers, rotating switches, physical indicators—to give users immediate, tangible control over their privacy. They share common characteristics: they are physical, tangible, and provide direct control through manipulation. Most importantly, they work by physically blocking or disabling sensors, giving users confidence that their privacy is protected through material, rather than digital, means. This has a direct benefit not only for novices but also experts.

Building on this context, we can speculate over a parallel concept: *physical attention-preserving mechanisms*. Just like privacy-preserving mechanisms designed to *physically* protect privacy,

TEI '26, Chicago, IL, USA

ACM ISBN 979-8-4007-1868-7/26/03
https://doi.org/10.1145/3731459.3779047

attention-preserving mechanisms might *physically* protect attention. However, unlike ambient interfaces that operate peripherally, we propose that primary interfaces can and perhaps should employ sensory reduction as attention-preserving mechanisms. What would such mechanisms look like? How might tangible interfaces be designed to preserve attention by reducing sensory engagement, rather than by operating in the periphery?

In an attempt to bolster calls to treat digital wellbeing as dynamic constructs [4] that require practice and intention, this studio introduces the concept of "attention-preserving tangible interfaces"—tangible interfaces designed to preserve attention in a world where devices increasingly scream for it. We do this not by operating peripherally like ambient interfaces, but by employing least sensing or sensory reduction in primary interfaces. These interfaces would reduce sensory engagement, requiring minimal sensory channels rather than demanding full attention through multiple sensory modalities. They would respect our focus by capping its use, employing sensory reduction as an attention-preserving mechanism. We will examine how physical attention-preserving mechanisms might be designed, speculating on what attention-preserving tangible interfaces that employ sensory reduction might look like in smart home contexts.

2 Detailed Proposal Description

This full-day studio will be conducted in-person at the Museum of Science and Industry in Chicago. The studio is designed to be hands-on and exploratory, bringing together theory and practice to examine how primary interfaces might employ least sensing or sensory reduction as attention-preserving mechanisms, building on the success of physical privacy-preserving mechanisms and acknowledging ambient interfaces as an alternative approach.

2.1 Format and Structure

The studio will accommodate 15-20 participants and will be fully in-person, allowing for hands-on work with physical materials and prototypes. Participants will work in small groups of 3-4 people, facilitating discussion and collaborative exploration. The format emphasizes active engagement over passive learning, with participants creating tangible prototypes that embody attention-preserving principles.

2.2 Core Activities

The studio will be structured around four main activities:

Activity 1: Examining Contexts for Attention-Preserving Interfaces (90-120 minutes) – Participants will begin by examining multiple contexts that inform attention-preserving tangible interfaces, including physical privacy-preserving mechanisms, ambient interfaces, and prior work on attention-preserving interfaces. Through hands-on exploration of sample devices (camera covers, microphone switches, physical indicators, ambient displays, and examples from prior research such as AttentionReceipts), groups will identify design principles and patterns across these different contexts. This activity establishes a foundation for thinking about attention-preserving mechanisms, distinguishing between peripheral approaches (ambient interfaces) and sensory reduction approaches (least sensing), while positioning privacy-preserving mechanisms as one inspiring context among others rather than a prescriptive methodology.

Activity 2: Prototyping Attention-Preserving Principles with Sensory Reduction (90-120 minutes) – Building on the first activity, participants will generate a set of design principles for attention-preserving tangible interfaces. In groups, they will develop heuristics, checklists, or questionnaires for themselves and also future designers to support designing with attention-preserving principles in mind. Participants will speculate on what primary interfaces that use sensory reduction might look like, drawing inspiration from the various contexts examined in Activity 1 (privacy-preserving mechanisms, ambient interfaces, and prior attention-preserving work) without being constrained by any single approach.

Activity 3: Exploring Sensory reduction in Primary Interfaces (90-120 minutes) – Building on the previous activities, participants will explore how primary interfaces can employ sensory reduction as an attention-preserving mechanism. Groups will design and prototype tangible interfaces that reduce sensory engagement in primary interactions, experimenting with minimal sensory channels, reduced feedback, and sensory reduction techniques. This activity focuses on applying least sensing principles to primary interfaces, not just peripheral ones.

Activity 4: Reflection and Discussion (60-90 minutes) – The studio concludes with groups presenting their prototypes and engaging in a facilitated discussion about the implications of attention-preserving tangible interfaces that employ sensory reduction. We will explore questions such as: What are the limits of sensory reduction as an attention-preserving mechanism? How do attention-preserving mechanisms that use sensory reduction differ from ambient interfaces? When might we still need immediate, attention-demanding interactions? How do attention-preserving mechanisms relate to privacy-preserving mechanisms? How does this reframing change our understanding of what tangibility means?

2.3 Participant Engagement

The studio is designed to be accessible to participants with varying levels of experience in tangible interaction and prototyping. No prior technical expertise is required, though familiarity with basic HCI concepts will be helpful. The emphasis is on exploration and critical thinking rather than technical implementation, making the studio suitable for researchers, designers, and practitioners interested in rethinking interaction paradigms in domestic spaces.

3 Grounding in Theory

Physical privacy-preserving mechanisms in smart homes demonstrate why physical, tangible mechanisms are more trustworthy than digital alternatives. Research by Windl et al. [1, 6] shows that users value physical mechanisms—such as camera covers and mechanical microphone switches—because they provide clear, unambiguous control that doesn't require understanding complex digital settings. These mechanisms work by physically blocking or disabling sensors, giving users confidence that their privacy is protected through material, rather than digital, means. The success of physical privacy-preserving mechanisms suggests that physical,

tangible mechanisms can effectively address concerns about smart home technologies.

While preserving privacy was and continues to be a major user need, we are now seeing a societal shift towards preserving attention. As smart home devices proliferate and compete for our cognitive resources, users are increasingly concerned not just about what technologies sense, but also about how they demand and disrupt attention. This shift reflects a broader recognition that attention is a limited resource that deserves protection, similar to how privacy has been understood as a fundamental right. Just as physical privacy-preserving mechanisms emerged to address privacy concerns through tangible, trustworthy controls, we now need attention-preserving mechanisms that address attention concerns through similar physical, tangible means.

Tangible interaction provides a foundation for understanding how physical mechanisms can serve as both representations and controls for digital information [2]. While foundational work emphasized the natural, intuitive nature of physical manipulation, more recent work has explored alternative framings of tangibility, including its role in peripheral awareness and ambient information display. This studio builds on these developments to explore how tangibility might be understood differently—not just as intuitive manipulation, but as a mechanism for preserving attention.

Tangible interfaces can preserve attention by employing least sensing or sensory reduction as attention-preserving mechanisms. The concept of least sensing suggests that interactions might require minimal sensory engagement rather than demanding full attention through multiple sensory channels. Sensory reduction extends this concept, proposing that interfaces can preserve attention by actively reducing sensory engagement, using fewer sensory channels or less sensory information. For example, an interface might use only haptic feedback instead of visual and auditory cues, or provide information through slow, minimal changes rather than immediate, attention-grabbing notifications. Unlike ambient interfaces that preserve attention by operating peripherally [5, 7], attention-preserving tangible interfaces would preserve attention by employing sensory reduction as a mechanism in primary interfaces. This represents a fundamental shift: instead of moving interactions to the periphery, we reduce the sensory engagement required by primary interactions. Prior work such as Attention Receipts [3] has demonstrated how a focus on materiality can help users understand and manage attention demands, providing physical representations of attention costs. This studio brings together these perspectives to explore attention-preserving tangible interfaces—physical mechanisms designed to preserve attention rather than demand it, building on the success of physical privacy-preserving mechanisms.

4 Materials to be Explored

4.1 Physical Materials and Prototypes

Participants will work with accessible, home-appropriate materials to create tangible prototypes that embody attention-preserving principles. These materials emphasize physicality, sensory qualities, and domestic familiarity over technological complexity. Materials include:

- **Cardboard and paper**: For rapid prototyping of physical forms and structures using familiar household materials
- **Textile materials**: Fabric, thread, buttons, and sewing supplies for soft, tactile interfaces that integrate naturally into home environments
- **Natural and organic materials**: Wood, stone, clay, cork, bamboo, beeswax, and other materials that change slowly over time and engage multiple senses subtly
- **Physical privacy-preserving mechanisms**: Examples of camera covers and microphone switches for reference and inspiration
- **Attention-preserving interfaces**: Examples from prior work such as Attention Receipts [3] that demonstrate tangible approaches to attention management

5 Learning Goals

By the end of this full-day studio, participants will:

(1) **Understand ambient interfaces and calm technology**: Participants will examine how ambient interfaces and calm technology preserve attention through peripheral operation, establishing a foundation for understanding alternative approaches.
(2) **Understand physical privacy-preserving mechanisms**: Participants will examine how physical privacy-preserving mechanisms work and why they are effective, establishing a foundation for thinking about attention-preserving mechanisms.
(3) **Explore least sensing and sensory reduction**: Participants will explore how primary interfaces can employ least sensing or sensory reduction as attention-preserving mechanisms, distinguishing this approach from peripheral operation.
(4) **Speculate on attention-preserving mechanisms with sensory reduction**: Participants will explore what physical attention-preserving mechanisms that employ sensory reduction might look like, drawing parallels to privacy-preserving mechanisms and considering how tangible interfaces might preserve attention through reduced sensory engagement.
(5) **Experience designing attention-preserving tangible interfaces**: Through hands-on prototyping, participants will gain practical experience creating tangible interfaces that preserve attention by employing sensory reduction in primary interfaces, using physical mechanisms to ensure minimal sensory engagement.
(6) **Reflect critically on attention in smart home contexts**: Participants will develop a deeper understanding of how smart home technologies compete for attention and explore how attention-preserving tangible interfaces that employ sensory reduction might offer alternatives to both attention-demanding devices and peripheral ambient interfaces.
(7) **Develop design principles for attention-preserving tangible interaction**: Through discussion and reflection, participants will identify key principles for designing tangible interfaces that preserve attention through sensory reduction, building on principles from privacy-preserving mechanisms and distinguishing from ambient interface principles.

(8) **Explore the limits and possibilities of sensory reduction**: Participants will critically examine when sensory reduction as an attention-preserving mechanism is appropriate and when more immediate, attention-demanding interactions might still be necessary.
(9) **Connect theory and practice**: Participants will see how theoretical concepts from ambient interfaces, privacy-preserving mechanisms, calm computing, least sensing, and tangible interaction can be applied in practical design contexts.
(10) **Build a community of practice**: Participants will connect with others interested in rethinking interaction paradigms in domestic spaces, creating opportunities for future collaboration.

These learning goals emphasize both theoretical understanding and practical skills, ensuring that participants leave with both new perspectives on attention-preserving tangible interfaces and hands-on experience creating physical attention-preserving mechanisms. Overall learnings and outcomes from this studio will be documented on a webpage that will be made available to the public (https://axlab-uofc.github.io/preserving-attention/).

5.1 Discussion and Hands-on Components

Discussion components are integrated throughout the studio, not just at the beginning and end. During prototyping activities, facilitators will circulate among groups, prompting reflection and discussion about design choices, particularly around how sensory reduction differs from peripheral operation. This approach ensures that theoretical concepts remain connected to practical work, and that participants have multiple opportunities to engage with the core ideas of the studio, particularly the relationship between ambient interfaces, privacy-preserving mechanisms, and attention-preserving mechanisms that employ sensory reduction.

References

[1] Youngwook Do, Jung Wook Park, Yuxi Wu, Avinandan Basu, Dingtian Zhang, Gregory D. Abowd, and Sauvik Das. 2021. Smart Webcam Cover: Exploring the Design of an Intelligent Webcam Cover to Improve Usability and Trust. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 5, 4 (Dec. 2021), 1–21. doi:10.1145/3494983

[2] Hiroshi Ishii and Brygg Ullmer. 1997. Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, Atlanta Georgia USA, 234–241. doi:10.1145/258549.258715

[3] Anup Sathya and Ken Nakagaki. 2024. Attention Receipts: Utilizing the Materiality of Receipts to Improve Screen-time Reflection on YouTube. In *Proceedings of the CHI Conference on Human Factors in Computing Systems*. ACM, Honolulu HI USA, 1–16. doi:10.1145/3613904.3642505

[4] Mariek M P Vanden Abeele. 2021. Digital Wellbeing as a Dynamic Construct. *Communication Theory* 31, 4 (Nov. 2021), 932–955. doi:10.1093/ct/qtaa024 Read_Status: Read Read_Status_Date: 2024-08-26T17:52:31.474Z.

[5] Mark Weiser and John Seely Brown. 1996. Designing Calm Technology. *PowerGrid Journal* 1, 1 (1996), 75–85.

[6] Maximiliane Windl, Albrecht Schmidt, and Sebastian S. Feger. 2023. Investigating Tangible Privacy-Preserving Mechanisms for Future Smart Homes. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. ACM, Hamburg Germany, 1–16. doi:10.1145/3544548.3581167

[7] Craig Wisneski, Hiroshi Ishii, Andrew Dahley, Matt Gorbet, Scott Brave, Brygg Ullmer, and Paul Yarin. 1998. Ambient Displays: Turning Architectural Space into an Interface between People and Digital Information. In *Cooperative Buildings. Integrating Information, Organizations, and Architecture*. Springer, Berlin, Heidelberg, 22–32. doi:10.1007/3-540-69706-3_4