# DESIGNING FOR RITUALS:
## CALIBRATING SLOW INTERACTION IN SOCIAL CONTEXTS WITH AN INTERACTIVE COASTER

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**ABSTRACT**

Many interactive systems are optimized for efficiency, yet everyday rituals, such as drinking, often benefit from friction and deliberate pacing. Slow Design offers an alternative lens for this inquiry. By introducing behavioral friction—resistance that demands conscious engagement—it naturally triggers the appraisal process for reflection, rather than simply switching a function on or off. This study investigates how such friction can be embedded into everyday objects and how people will experience it in different social contexts. We combined the research-through-design approach and Kansei Engineering methods in designing an interactive coaster across three phases. First, we collected a diverse set of coaster samples and selected 15 representative samples to evaluate users' emotional perceptions using a Semantic Differential survey (N=32). The Exploratory Factor Analysis yielded three key factors that accounted for 88% of the variance. They are *emotional expression and style*, *technology and manufacturing orientation*, and *value and durability*. Second, guided by these findings and Slow Design principles, we developed an NFC-enabled interactive coaster offering multi-sensory feedback through ambient LED lighting and an AI-curated application for mood logging and shared history. Third, we evaluated the prototype in two situated contexts: a commercial bar (N=5) and a domestic setting (N=3). Participants in both contexts valued the coaster's tactile materiality and ambient light; in solitary use, high-friction mood logging turned waiting into a "healing" ritual, and ambient cues opened conversations. Explicit app interaction, however, interrupted group conversation, revealing a core tension: friction that affords reflection in solitude becomes disruption in company. We contribute three design provocations—Gentle Revelation from the reach of peripheral cues, Reflective Pacing from the divergent reception of enforced delay, and Contextual Interaction Friction from the tension itself—reframing friction as a deliberate affordance that must be dynamically calibrated to social context, not universally prescribed.

*Keywords:* *Slow Design, Slow Technology, Tableware, Interactive Design*

## 1 INTRODUCTION

In contemporary ubiquitous computing, product design prioritizes efficiency and friction reduction. While these priorities have yielded highly optimized "smart" systems, they often inadvertently strip daily routines of the friction necessary for mindfulness, reducing meaningful human–object interactions to instrumental tasks (Hassenzahl, 2010; Hassenzahl et al., 2010; Norman, 2004). This motivates the deliberate reintroduction of meaningful friction and temporal pacing into routine interactions to support contemplation and self-awareness.

Research in slow design (Fuad-Luke, 2002) and slow technology (Hallnäs & Redström, 2001) has advocated for interaction qualities that introduce pauses, anticipation, and material engagement to support mindfulness and emotional awareness. Strauss and Fuad-Luke (2008) articulate six core principles of Slow Design, which serve as the theoretical and practical framework: (i) Reveal: Uncovering often-overlooked processes, resources, and impacts within daily life, (ii) Expand: Extending the implications of design into broader social and cultural contexts, (iii) Reflect: Facilitating user introspection regarding their own behaviors and values, (iv) Engage: Encouraging active engagement rather than passive consumption, (v) Participate: Emphasizing co-creation between designers and users, and (vi) Evolve: Allowing design to mature and develop over time, rather than being finalized at the point of manufacture.

Through Kansei Engineering (KE) analysis, designers can identify and select material parameters that accumulate emotional value over time, thereby translating abstract slow-design principles into concrete, executable design strategies (Schütte, 2005). The distinction between process and outcome is central to our theoretical framing. Unlike Reflective Design, which primarily targets cognitive introspection as its end goal, Slow Design operates at the behavioral level first: deliberate material resistance and interaction friction break automaticity, triggering the appraisal process through which reflection becomes possible (Odom et al., 2022; Strauss & Fuad-Luke, 2008). This grounding guided our semantic differential (SD) survey (Osgood, 1957) and the EFA-guided design space toward a coaster with the qualities of emotional richness, high interactivity, and humor—the three underserved dimensions in which slow design could be embedded into a daily artifact.

In design practice (Cox et al., 2016; Grosse-Hering et al., 2013; Marsh, 2016), however, much of the existing literature assumes that slowness is inherently positive, overlooking how "slow interactions" are perceived across varied social contexts. To address this gap, based on the design-identified space, we applied a Research through Design (RtD) approach (Zimmerman et al., 2010) to develop and evaluate a slow-designed interactive coaster in situated social contexts.

Taken together, the central research question guiding this study is: (1) how can behavioral friction be deliberately embedded into a familiar everyday object to support ritual and reflection, and (2) how is its value shaped by social context? We address this through two sub-questions: (RQ1) How can Kansei Engineering and Slow Design principles translate abstract “slowness” into a concrete interactive artifact? (RQ2) Does the friction that fosters mindful reflection in solitary use disrupt the flow of interaction in group settings?

The findings yield three design provocations (Odom, 2024). Rather than treating friction as an obstacle, these provocations—Gentle Revelation, Reflective Pacing, and Contextual Interaction Friction—reframe it as a deliberate affordance whose demands are calibrated to social context, moving slow design from the philosophical toward the actionable.

## 2 METHODS

To operationalize slow design principles, this study adopted a Research through Design (RtD) (Zimmerman et al., 2010) approach spanning three phases: (i) quantitative Kansei Engineering, (ii) prototype development, and (iii) qualitative design evaluation.

### 2.1 Phase I: Quantitative Kansei Engineering

#### 2.1.1 Sample Selection and Instrument Development

To understand drink-related rituals in everyday life, we conducted field observations at various venues (e.g., bars, coffee shops) and domestic settings. Observing how people interacted with tableware informed our design brainstorming and led to the curation of 15 distinct coaster samples (see Figure 1). To evaluate user perceptions and interaction experiences with these artifacts, we developed a semantic differential (SD) survey (Osgood, 1957) with 10 selected bipolar adjective pairs.



**Figure 1:** The fifteen diverse coaster design samples collected and used in our survey to discover unmet user needs.

The initial bipolar adjective pairs were selected from the product aesthetics vocabulary proposed by Johnson et al. (2003) and mapped through the lens of slow design theory (Strauss & Fuad-Luke, 2008). The adjective pairs were predominantly collected from the 'Perception-Symbolic' category in Johnson et al. (2003)'s work. This concentration is a deliberate methodological choice, as slow design is fundamentally a meta-cognitive approach. It aims to uncover hidden processes (Reveal), trigger user introspection (Reflect), extend cultural implications (Expand), demand active cognitive involvement (Engage), emphasize designer-user co-creation (Participate), and allow the object's meaning to mature over time (Evolve), rather than merely manipulating physical 'Aesthetics-Sensory' attributes.

Furthermore, a pilot test with 5 participants indicated that strict adherence to the original academic terminology (e.g., Ornamental vs. Functional) caused ambiguity. Consequently, the survey was adapted to utilize more accessible vocabulary (e.g., Emotional vs. Functional). The finalized 10-item scale operationalizes five of the six slow design principles (see Appendix)—

excluding Participate, which is defined as a co-creation process during the development phase rather than as perception during the use phase. Finally, 32 participants rated the 15 coaster samples using this adapted 10-item, seven-point Likert-type scale.

### 2.1.2 Procedure and Data Analysis

After conducting the semantic differential rating, we applied Exploratory Factor Analysis (EFA) to condense the semantic ratings into a set of underlying Kansei factors. The EFA established a three-factor structure: Emotional Expression and Style (Factor 1), Technology and Manufacturing Orientation (Factor 2), and Value and Durability (Factor 3) (see Table 1), accounting for 87.94% of the variance. We then plotted the 15 coaster samples across the three-factor space using a three-dimensional rotation map (see Figure 2), which visualizes each sample's position relative to all three Kansei factors simultaneously. By examining which region of this space was underserved—specifically, artifacts that score high on emotional richness, high interactivity, and humor remain rare among existing products—we derived the unmet design opportunity that guided prototype development.

**Table 1.** Rotated Component Matrix of exploratory factor analysis (EFA)

| Bipolar Adjective Pairs | Solution 1 | Solution 2 | Solution 3 |
|---|---|---|---|
| Low-tech vs. High-tech | 0.923 | -0.046 | 0.313 |
| Handmade vs. Manufactured | 0.908 | 0.041 | -0.261 |
| Low Interactive vs. High Interactive | 0.908 | -0.199 | 0.02 |
| Classic vs. Trendy | 0.795 | -0.475 | -0.108 |
| Emotional vs. Functional | 0.269 | 0.901 | -0.076 |
| Humorous vs. Humorless | -0.324 | 0.792 | 0.318 |
| Monotonous vs. Rich | 0.324 | -0.739 | 0.292 |
| Novel vs. Ordinary | -0.625 | 0.7 | -0.248 |
| Durable vs. Disposable | 0.258 | -0.041 | -0.893 |
| Cheap vs. Expensive | 0.489 | -0.225 | 0.81 |

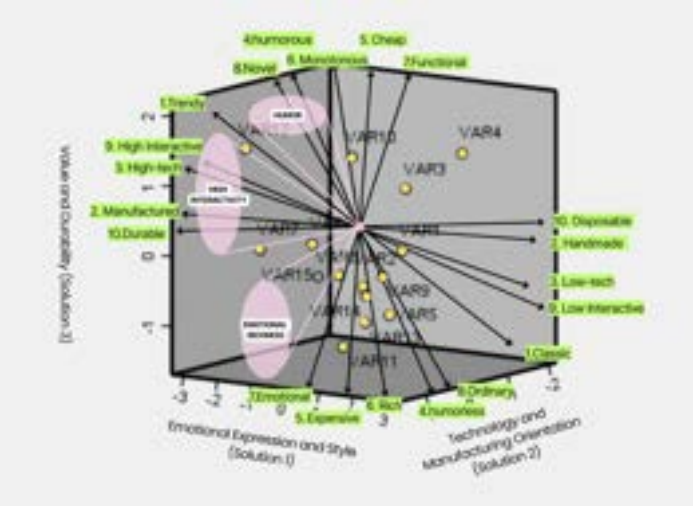



**Figure 2.** Mapping the EFA result in three-dimensional space reveals the unmet design opportunity.

## 2.2 Phase II: Prototype Development and Slow Design Integration

Guided by the findings in Phase I and Slow Design principles (Strauss & Fuad-Luke, 2008), we developed the "Slow Coaster," an NFC-enabled artifact designed to introduce meaningful friction into the drinking ritual.

### 2.2.1 The Physical Artifact: Visceral Friction

The coaster is handcrafted from irregular glass, a material choice driven by the slow design principles (Strauss & Fuad-Luke, 2008) of Reveal and Reflect. Unlike the smooth uniformity of industrial plastic, the glass's uneven texture and weight distribution introduce tactile "visceral friction," forcing the user to handle the object with conscious care rather than mindless automaticity (Pallasmaa, 2024). Crucially, the LED light embedded in the coaster provides ambient feedback and high interactivity at the visceral level (Chuang, 2020; Norman, 2007). By compelling the user to handle the object with focused sensory engagement—consisting of tactile and subtle visual cues—the design shifts the interaction from a mindless placement to a conscious, mindful ritual (Karana, Barati, et al., 2015; Karana, Pedgley, et al., 2015).

### 2.2.2 The Digital Interface: Reflective Pacing

The NFC tags embedded under the coaster link the physical artifact to a web-based application designed for Reflection (Strauss & Fuad-Luke, 2008). The system challenges the "instant access" paradigm through the following mechanisms:




**Figure 3.** The main interactions of using the interactive coaster prototype developed in this study: (A) Launch the App by tapping a smartphone on the coaster. (B) The App launches at a deliberate pace to slow down a user's mind. (C) A user reflects on their current mental state and logs their mood. (D) The system sets a corresponding atmosphere with matched light color and music. (E) A user can also revisit their past reflections and listening history. He/she can also browse other people's publicly shared data.

High-Friction Entry: Users must physically scan the coaster to launch the app (see Figure 3A), breaking the stimulus-response loop of standard notifications.

**Temporal Buffering:** The app interface purposefully loads at a deliberate pace (see Figure 3B), transforming the wait time into a moment of anticipation and mental transition

**Emotional Mirroring:** Users log their current mood (see Figure 3C), which the system translates into matched ambient light colors on the coaster and an AI-curated playlist (see Figure 3D), externalizing internal states using the environment to mirror the user's emotions (Boehner et al., 2007; Norman, 2007).

**AI and Social Connection for Humor:** The app integrates a witty music recommendation engine based on the user's mood and written notes, and provides a 'digital footprint' (music/mood history) left by previous users of the same coaster (Figure 3E), fostering long-term emotional durability in a shared context (Chapman, 2012; Hassenzahl, 2010; Hassenzahl et al., 2010). In this study, multiple Spotify playlists were predefined to simulate AI functionality, each containing more than 10 songs that express a particular mood.

### 2.3 Phase III: Qualitative Design Evaluation

To evaluate how social context influences the experience of "slowness," we conducted a situated test in two contrasting environments: a lively commercial bar (N=5, one group setting and three solitary settings) and a quiet domestic living room (N=3, one group setting and one solitary setting) (see Table 2). The bar setting was deliberately chosen to introduce environmental complexity—noise, ambient lighting, and ongoing social dynamics—as a stress test for the design's contextual adaptability. Within this setting, professional staff (P1, bartender; P2, waitress; P5, bar owner) were intentionally recruited alongside regular customers to capture expert perspectives on how such a design might function in a real commercial deployment, including its impact on service flow and customer experience at scale. Consistent with the exploratory nature of Research through Design, this small purposive sample (N=8) prioritizes contextual richness over statistical generalizability.

**Table 2.** Participant overview for the Phase III design evaluation

| Participant | Setting | Social Context | Role |
|---|---|---|---|
| P1 | Bar | Solitary | Bartender |
| P2 | Bar | Solitary | Waitress |
| P3 | Bar | Group | Customer |
| P4 | Bar | Group | Customer |
| P5 | Bar | Solitary | Bar Owner |
| P6 | Domestic | Group | Participant |
| P7 | Domestic | Group | Participant |
| P8 | Domestic | Solitary | Participant |

**Procedure:** Participants were invited to use the coaster during a standard drinking session involving either tea, coffee, or alcohol. We employed a Wizard-of-Oz protocol to simulate the system's "emotional mirroring" light features, allowing researchers to trigger light changes in

response to user inputs manually, ensuring consistent timing. Participants were instructed to pour or order a drink, scan the coaster to launch the web app, log their current mood, and interact with the artifact while consuming their beverage.

Data Collection: We gathered qualitative data through direct observation during the 20-minute sessions and semi-structured post-study interviews. Our analysis focused on capturing micro-interactions—specifically, how users negotiated high-friction features (scanning, loading delays) amid the distractions of a bar versus the quiet of a home.

## 3 FINDINGS

The interview data were first transcribed, and two researchers independently coded the transcriptions. We then used thematic analysis (Braun & Clarke, 2006) to cluster the codes and identify the most important themes. Participants recruited in the bar context were coded as P1-P5, and those in the domestic context as P6-P8. In the bar setting, P1 (bartender), P2 (waitress), and P5 (bar owner) offered professional perspectives on the design. Participants P3 and P4 and P6 and P7 tested the design in group settings. During our analysis, we focused on emotional resonance, ritual formation, and the influence of social context on the acceptance of "slow" interaction features.

Our findings highlight a clear contrast in how "slowness" was perceived across social settings. While all participants in both contexts praised the physical (glass) and ambient (light) features, the explicit interactions (app/mood-logging) revealed a sharp divide between solitary introspection and social flow. The three primary themes are presented below.

### 3.1 Solitary Resonance: The "Healing" Ritual

In moments of solitude or quiet reflection, the system's high-friction design successfully fostered mindfulness. Participants described the experience as a "healing" process, with P2, P3, P6, and P8 noting that the pacing helped them enter a state of *"mental emptiness"* and *"relaxation."* Specifically, we observed the following two reflective behaviors.

Introspection: P1, P2, and P5 highlighted that the mood-logging feature facilitated an *"awareness of the present self."* P5 (Bar Owner) specifically noted that for solitary customers, the slow interaction transformed the idle time of waiting for a drink into a *"ritualistic experience,"* creating a psychological space for self-dialogue.

Reframing Friction: Although P6 and P7 initially found the NFC scanning and slow app loading unfamiliar and annoying, they ultimately reported that this friction forced them to *"be in the present."* During the testing, they were intrigued by the combination of tangible and digital interaction the design offered, realizing the purpose of slow design in bringing them to the present.

### 3.2 Social Dissonance: Friction as Disruption

In contrast, the same "slow" features often failed in group settings, where participants prioritized conversation over device interaction. This was the most consistently substantiated

finding in our evaluation: six of eight participants (P1, P2, P3, P4, P5, and P6) reported that slow interactions were undesirable in social contexts because they interrupted the natural flow of interaction among people. Essentially, it was due to the interruption of social flow, in which a user needs to focus on what is shown on their phone rather than on social interactions. P6 provided the most direct critique of this tension: *"When friends are there, I don't want to spend time selecting my mood—I want to interact with them."* This suggests that while the artifact (coaster) belongs on the table, the interaction (looking at a phone) signals social disengagement.

In addition, the professional participants (P1, P2, and P5) identified scalability issues in the two distinct contexts. P5 (Bar Owner) observed that while the experience creates an intimate atmosphere for couples or solo drinkers, it is *"inapplicable to large-scale group gatherings"* where high-privacy immersion is impossible.

### 3.3 Ambient Connection vs. Environmental Conflict

While the active app usage caused friction, the passive ambient features (light and music) bridged the gap between contexts. P4 and P7 noted that the mood history in the App and light colors shown on the coaster served as effective *"topic-openers"* for starting conversations with others, especially with strangers or guests. P2 and P3 found that the colors of lights helped them ask friends about their feelings. P5 envisioned the coaster as a data-driven "*ice-breaking intermediary"* for bartenders to customize service.

Again, professionals foresaw challenges in future deployments. P1 (Bartender) and P5 warned of "sensory interference," noting that the coaster's light and music could conflict with the bar's existing atmosphere (background music and lighting). This indicates that slow technology cannot simply overlay an existing environment but must respect its sensory hierarchy.

## 4 DISCUSSION

Current research on slow technology and design often frames deceleration and friction as universally positive attributes that foster mindfulness and meaning-making (Cox et al., 2016; Grosse-Hering et al., 2013; Marsh, 2016). However, our situated investigation reveals a critical limitation in this view: the same "slowness" that facilitates healing and reflection in solitude is often perceived as a social "interruption" in group settings. This suggests that the value of slow interaction is not inherent to the device but is contingent upon the social context. We propose that successful slow design must move beyond static friction toward dynamic calibration, guided by three design insights. We also identified one research gap in digital humor design.

### 4.1 Gentle Revelation: Prioritizing "Calm" over "Immersion "

Traditional interactive systems often compete for user attention through direct notifications (vibrations, sounds). While slow design advocates for "rich" experiences (Strauss & Fuad-Luke, 2008), our findings in the bar context highlight a risk of sensory overload. Participants rejected high-fidelity feedback (music and screen interactions) because it conflicted with the bar's existing auditory landscape.

Instead, we propose the strategy of Gentle Revelation. Drawing on Weiser's principles of calm technology (Weiser & Brown, 1996, 1997), slow interfaces in social spaces should not demand cognitive processing but rather invite it through "peripheral cues." Our participants' preference for the ambient light—which could be ignored or attended to at will—demonstrates this principle. Unlike "immersive" systems that sequester the user, a "gentle" system unfolds information gradually (Weiser & Brown, 1996), ensuring the artifact supports the social atmosphere rather than hijacking the conversation.

### 4.2 Reflective Pacing: From "Explicit" to "Opt-in" Slowness

How should friction be implemented? Odom (2024) distinguishes between Explicit Slowness (where the system restricts control to force a pause, e.g., the Photobox (Odom et al., 2010)) and Implicit Slowness (where the system invites reflection but remains open). Our study provides empirical evidence that Explicit Slowness is fundamentally incompatible with social flow. When our system enforced a "loading delay" to induce mindfulness, users in the bar felt it was a "bug" or an awkward pause that severed eye contact with friends.

Therefore, we argue that socially situated devices must utilize Opt-in Friction. The artifact should default to a "Low-Friction Ambient" state (e.g., subtle lighting) to preserve the social rhythm, transforming into a "High-Friction Ritual" state only when the user creates a "micro-boundary" by actively engaging (Cox et al., 2016)—such as physically scanning the coaster. This resolves the tension identified in our findings: users desire the option for deep engagement (Ritual) without the intrusion of enforced delays (Interruption) (Sengers et al., 2005).

### 4.3 Contextual Interaction Friction: Leveraging Social Awareness

Finally, we challenge the binary view of "fast" vs. "slow" design. Most context-aware computing utilizes sensor data to eliminate friction and predict user needs (Dey, 2001). We argue for an inverse approach: leveraging context to strategically insert friction. In solitary contexts, the system should increase interaction friction (e.g., by requiring tangible inputs or mood logging). Here, the delay is not inefficiency but the "value proposition" itself, creating headspace for self-dialogue (Sengers et al., 2005). In group settings, the system must shift to seamless operation; features such as "social history" should serve only as passive icebreakers (Weiser & Brown, 1997) rather than as active tasks.

This implies that "slowness" must be socially context-aware (Hallnäs & Redström, 2001). Future slow technology should not only sense where the user is but whom they are with, dynamically matching the effort it demands to the social etiquette of the moment.

### 4.4 Physical Symbolism and the Limits of Digital Humor

The original Kansei Engineering analysis identified Humor as a key emotional attribute in the design space, informed by benchmark products—such as zoomorphic coasters—whose symbolic physical forms directly trigger meaning at the "Experience of Meaning" level (Karana, Barati, et al., 2015). By contrast, the handcrafted glass prototype operates primarily at the visceral level, offloading the "unexpected" dimension onto digital feedback: AI-curated music recommendations and ambient light responses.

Within a single 20-minute session, these digital surprises proved insufficient to establish the depth of emotional connection or genuine humor response that strong physical metaphor can achieve more immediately. This exposes a cross-medium design gap: static physical symbolism encodes humor durably through material form, whereas dynamic digital feedback requires repeated exposure to accumulate equivalent meaning. A productive direction for future Kansei tangible computing research lies in how to more deeply integrate the dynamic responsiveness of AI software with the durable symbolic resonance of physical hardware, achieving coherent humor across both levels of experience.

## 5 CONCLUSIONS AND LIMITATIONS

This study employed a three-phase Research through Design methodology to investigate how slow design principles can be embedded in a familiar daily object. In Phase I, a Kansei Engineering Type I approach (a Semantic Differential survey; 15 samples, N=32) yielded three factors via Exploratory Factor Analysis (explaining 88% of the variance) and revealed an unmet design opportunity: artifacts that combine emotional richness, high interactivity, and humor remain rare among existing coasters. Guided by this gap, Phase II produced the *Slow Coaster*: an NFC-enabled, handcrafted glass coaster with embedded ambient LED feedback and a web application that supports mood logging, AI-curated music, and a shared social history.

Phase III evaluated the prototype in a commercial bar (N=5) and a domestic setting (N=3) using a Wizard-of-Oz protocol. Analysis revealed three themes: *Solitary Resonance* (high-friction features fostered mindful "healing" rituals in quiet contexts); *Social Dissonance* (the same features disrupted the flow of group conversation); and *Ambient Connection* (passive ambient cues served as low-friction conversation starters across both contexts). From these findings, we propose three design provocations: *Gentle Revelation* (using peripheral ambient cues rather than attention-demanding notifications), *Reflective Pacing* (defaulting to low-friction ambient states with opt-in ritual engagement), and *Contextual Interaction Friction* (dynamically calibrating interaction effort to social etiquette). Together, they argue that slowness must be socially calibrated rather than universally prescribed.

Several limitations bound these contributions. The AI music recommendation and emotional mirroring light were simulated using predefined playlists and a Wizard-of-Oz protocol, which constrained claims about long-term responsiveness and personalization; future work should deploy a fully functional AI backend to evaluate whether genuine dynamic personalization deepens reflective and humorous qualities over time. The social history feature relied entirely on pre-built data so that a live deployment will require explicit consent mechanisms and careful privacy design around data ownership and opt-in transparency. Finally, the small sample size (eight participants across two contexts) limits the generalizability of these findings and captures *ritual initiation* rather than ritual formation; longitudinal deployment with a larger and more diverse sample is necessary to examine whether initially disruptive friction is reframed as ritualistic through habituation, and whether the proposed provocations generalize across broader social configurations.

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## REFERENCES

Boehner, K., DePaula, R., Dourish, P., & Sengers, P. (2007). How emotion is made and measured. *International Journal of Human-Computer Studies*, *65*(4), 275–291. https://doi.org/10.1016/j.ijhcs.2006.11.016

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chapman, J. (2012). *Emotionally durable design: Objects, experiences and empathy*. Routledge.

Chuang, Y. (2020). Designing the expressivity of multiple smart things for intuitive and unobtrusive interactions. In *Proceedings of the conference on designing interactive systems* (pp. 2007-2019). ACM. https://doi.org/10.1145/3357236.3395450

Cox, A. L., Gould, S. J., Cecchinato, M. E., Iacovides, I., & Renfree, I. (2016). Design frictions for mindful interactions: The case for microboundaries. In *Proceedings of the SIGCHI conference on human factors in computing systems* (Extended abstracts, pp. 1389-1397). ACM. https://doi.org/10.1145/2851581.2892410

Dey, A. K. (2001). Understanding and using context. *Personal and Ubiquitous Computing*, *5*(1), 4–7. https://doi.org/10.1007/s007790170019

Fuad-Luke, A. (2002, December 2). *Slow design: A paradigm shift in design philosophy*. Paper presented at the 2nd international conference on open collaborative design for sustainable, Bangalore, India.

Grosse-Hering, B., Mason, J., Aliakseyeu, D., Bakker, C., & Desmet, P. (2013). Slow design for meaningful interactions. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 3431-3440). ACM. https://doi.org/10.1145/2470654.2466472

Hallnäs, L., & Redström, J. (2001). Slow technology–designing for reflection. *Personal and Ubiquitous Computing*, *5*(3), 201–212. https://doi.org/10.1007/PL00000019

Hassenzahl, M. (2010). *Experience design: Technology for all the right reasons*. Springer. https://doi.org/10.1007/978-3-031-02191-6

Hassenzahl, M., Diefenbach, S., & Göritz, A. (2010). Needs, affect, and interactive products–Facets of user experience. *Interacting with Computers*, *22*(5), 353-362. https://doi.org/10.1016/j.intcom.2010.04.002

Johnson, K. W., Lenau, T., & Ashby, M. F. (2003). The aesthetic and perceived attributes of products. In *Proceedings of the 14th international conference on engineering design* (pp. 173-174). Design Society.

Karana, E., Barati, B., Rognoli, V., & Zeeuw Van Der Laan, A. (2015). Material driven design (MDD): A method to design for material experiences. *International Journal of Design*, *9*(2), 35–54.

Karana, E., Pedgley, O., & Rognoli, V. (2015). On materials experience. *Design Issues*, *31*(3), 16–27. https://www.jstor.org/stable/43829331

Marsh, T. (2016). Slow serious games, interactions and play: Designing for positive and serious experience and reflection. *Entertainment Computing*, *14*, 45–53.

Norman, D. A. (2004). Introduction to this special section on beauty, goodness, and usability. *Human–Computer Interaction*, *19*(4), 311-318. https://doi.org/10.1207/s15327051hci1904_1

Norman, D. A. (2007). *Emotional design: Why we love (or hate) everyday things*. Basic Books.

Odom, W. (2024). Illustrating, annotating & extending design qualities of slow technology. In *Proceedings of the NordicCHI conference on human-computer interaction* (Adjunct, Article No.74). ACM. https://doi.org/10.1145/3677045.3685499

Odom, W., Banks, R., & Durrant, A. (2010). Designing for slowness, anticipation and re-visitation: A long term field study of the photobox. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1961-1970). ACM. https://doi.org/10.1145/2556288.255717

Odom, W., Stolterman, E., & Chen, A. Y. S. (2022). Extending a theory of slow technology for design through artifact analysis. *Human–Computer Interaction*, *37*(2), 150-179. https://doi.org/10.1080/07370024.2021.1913416

Osgood, C. E. (1957). *The measurement of meaning*. University of Illinois.

Pallasmaa, J. (2024). *The eyes of the skin: Architecture and the senses*. John Wiley & Sons.

Schütte, S. (2005). *Engineering emotional values in product design—Kansei engineering in development* [Unpublished doctoral dissertation]. Linköping University, Sweden.

Sengers, P., Boehner, K., David, S., & Kaye, J. J. (2005). Reflective design. In *Proceedings of the 4th decennial conference on critical computing* (pp. 49-58). ACM. https://doi.org/10.1145/1094562.1094569

Strauss, C., & Fuad-Luke, A. (2008, July 12). *The slow design principles*. Paper presented at the conference on changing the change, Politecnico di Milano and Politecnico di Torino, Turin, Italy.

Weiser, M., & Brown, J. S. (1996). Designing calm technology. *PowerGrid Journal*, *1*(1), 75-85.

Weiser, M., & Brown, J. S. (1997). The coming age of calm technology. In *Beyond calculation: The next fifty years of computing* (pp. 75-85). Springer.

Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010). An analysis and critique of research through design: Towards a formalization of a research approach (pp. 310-319). In *Proceedings of the 8th conference on designing interactive systems*. ACM. https://doi.org/10.1145/1858171.1858228

## APPENDIX

Table A1 presents the final 10 bipolar adjective pairs selected in this study, which were operationalized across five of the six slow design principles.

| Bipolar Adjective Pairs | Mapped Slow Design Principle | Rationale for Mapping |
|---|---|---|
| Low-tech vs. High-tech | Reveal | Low-tech mechanisms transparently uncover everyday processes that are typically obscured by complex digital integration. |
| Handmade vs. Manufactured | Reveal | Traces of manual crafting explicitly reveal the resources, time, and human labor invested in the creation process. |
| Cheap vs. Expensive | Reveal | The perceived cost or exclusivity directly reveals underlying socioeconomic implications and material value. |
| Emotional vs. Functional | Reflect | Emotional designs foster deep affective connections, prompting users to introspect on their personal values and memories. |
| Novel vs. Ordinary | Reflect | Unconventional forms disrupt automatic usage patterns, forcing users to pause and reflect on their behaviors. |
| Low Interactive vs. High Interactive | Engage | High interactivity (e.g., intentional friction) demands cognitive and physical effort, encouraging active engagement over passive consumption. |
| Monotonous vs. Rich | Engage | A high density of visual or sensory details requires active exploration, preventing the user from processing the object passively. |
| Humorous vs. Humorless | Expand | Playful and humorous elements subvert expectations, extending the design's implications into broader cultural and social contexts. |
| Classic vs. Trendy | Evolve | Classic designs embody historical permanence, allowing the object's meaning to mature and develop over time. |
| Durable vs. Disposable | Evolve | Physical longevity provides the necessary material foundation for an object to age sustainably and evolve alongside the user. |