

Learning From Users: Everyday Playful Interactions to Support Architectural Spatial Changes

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While there's growing interest in eliciting situated playful interactions with technologies in different contexts, how these interactions might shape everyday spaces still needs to be fully explored. To address this gap, this article aims to guide the architectural spatial changes by exploring everyday playful interactions of technology-adopted users in domestic spaces. We present our contributions in a two-fold study: First, through an extensive diary study involving 13 technology-adopted residents in gated communities, where distinct boundaries offer increased opportunities for playful interactions, we identified four playful themes: (1) creating and expanding play-spaces, (2) balancing play and comfort, (3) intertwining imagination with spatial experience, and (4) gamifying household interactions. Secondly, by building on these themes, we outline three design implications to inform architectural design processes, aiming to translate everyday playful interactions into tangible spatial changes. These implications include adapting shape-changing and wearable technologies for playful flexibility, embedding new forms of communications within infrastructures, and turning homes into interactive entities with multi-sensory technologies. While these findings provide a starting point for exploring new architectural design possibilities in similar environments, further research with architects, policymakers, and design researchers in the Human-Computer Interaction (HCI) and Human-Building Interaction (HBI) fields is essential to actualizing these changes.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; **User studies**.

Additional Key Words and Phrases: playful interaction, situated play design, spatial change, architectural change, home, human-building interaction

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1 Introduction

Architectural change is becoming a prominent area of research in the Human-Computer Interaction (HCI) community, focusing on comprehending the relationship between users and their surroundings. Moving beyond the domain of artifacts to include architecture [2], this research aligns with the emerging field of Human-Building Interaction (HBI), marking an expansion to encompass the dynamic relationship between people and the buildings they inhabit. Users play a crucial role in this change, and homes are integral to their daily experiences [4]. While smart home technologies like the Internet of Things (IoT) have made significant progress, previous research predominantly focuses on investigating their functional influence on architectural spaces [13]. However, as technologies extend into daily life, users' perceptions of home are reshaped through

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cultural and emotional interactions [26]. Consequently, these fields broaden their scope to include various technological applications in homes, highlighting a shift towards increased attention to *playful interactions* [11].

While playful interactions hold different meanings, within this research, they are considered as *features that encourage users to explore alternative functions [49] and result in experiences characterized by enjoyment or positive emotional states [11].* An example of these interactions includes piano stairs in public spaces, which offer a fun alternative to climbing stairs with music [64]. Following the widespread use of technologies, everyday objects also increasingly evoke emotional responses and serve purposes beyond their apparent functions, such as mobile phones functioning as personal assistants [23] or refrigerators used for diet control [89]. This exploratory nature of technologies contributes to a sense of playfulness, with users actively shaping the meanings associated with them.

To investigate playful aspects, Situated Play Design (SPD) approach is employed to investigate open-ended, non-entertainment-based activities in various contexts as *play potentials*, such as food [7], social media [9], cities [5], and nature [6], resulting in a catalog of speculative design ideas on technologies. While these studies highlight play potentials in different contexts, there is an underexplored aspect concerning play as an embodied and co-located action that enhances the architectural experience [98]. This calls for further research into the interaction between playful interactions and spatial changes within the human-built environment [81] and the potential implications of this interaction on the architectural transformation of homes in the future [4].

Addressing the foretold gap, we formulated our research question as: **What are the everyday playful interactions of technology-adopted users in domestic spaces that might guide architectural spatial changes?** Given the continuously evolving demand for new residential developments, addressing this inquiry holds importance to ensure future domestic spaces are suitable for technology-adopted individuals' preferences amidst this transforming playful landscape. To pursue this inquiry, we focused on the peripheral gated communities in Istanbul due to urban boundaries' capacity to foster playfulness [91]. We initiated our investigation with a preliminary study, conducting 17 user interviews to identify elements of daily home life that users perceive as playful. Following this, we carried out a diary study with 13 residents from various peri-urban areas of Istanbul to gather diverse and in-depth insights into their everyday playful interactions. We identified 12 play potentials across four thematic categories: (1) creating and expanding play-spaces, (2) balancing play and comfort, (3) intertwining imagination with spatial experience, and (4) gamifying household interactions. After uncovering play potentials, we explored how everyday playful interactions could be translated into tangible spatial changes. This exploration led to the discussion of three design implications: tailoring spatial flexibility for shape-changing playful interactions, embedding communication variability in the home structure, and turning home into a playmate by shifting the use of architectural elements. These implications are intended to open a dialogue on the design of future spaces through a reciprocal integration of users' playful interactions with technologies and domestic environments.

Overall, our contribution is two-fold: (1) We provided *spatial play potentials* based on users' interactions with technologies and spaces that may trigger new design directions. (2) We revealed *design implications* that showcases the potential of using these play potentials for ideation. In the future, we envision this research providing valuable insights for architects, designer researchers in HCI and HBI, and policymakers to guide studies in various architectural contexts that move beyond merely incorporating technologies and instead integrate playful interactions to create domestic spaces that adapt and respond to users' needs and expectations.

2 Background

2.1 Architectural Space and Need for Change

In today's understanding, where technology permeates every aspect of life and frames numerous interactions [94], architectural space is defined as a *social space* of dynamic interactions between people and their environments [61]. As users increasingly engage with technologies in diverse manners to include playful aspects [26], architectural spaces have the opportunity to follow this transformation on different scales. Under this consideration, we specifically focus on spatial changes at the building level to contribute to the understanding of architectural transformations in domestic spaces (i.e., homes) within the Human-Building Interaction (HBI) field [3]. According to HBI, buildings are designed to organize different functional spaces [48], essentially serving as physical interfaces that enable various daily activities [3] and shape how users perceive the world [31].

Brand [22] proposed the concept of *Shearing Layers* to examine how buildings evolve in response to technological advancements. This framework explains the different temporal rates of change among a building's components across six layers: stuff, space plan, services, skin, structure, and site. These layers continuously influence one another, contributing to the ongoing reshaping of a building over time. For example, the stuff layer (i.e., objects and furniture) constantly changes, while the space plan evolves every three to thirty years. Transformations in these layers do not affect the buildings' structure, indicating *minor changes* [83]. Conversely, the subsequent four layers require a longer time to change, yet they have the potential to induce *major changes* in the structure of buildings [27].

Introducing technologies into domestic settings has led to a few yet profound architectural spatial changes. For example, the emergence of refrigerators changed the infrastructure of homes by eliminating the need for kitchen storage areas [27] as they replaced the function of keeping food fresh [68]. Additionally, flexible architecture systems provided minor spatial modifications within homes. Modular systems [88] and the implementation of open floor plans facilitated the creation of multi-functional spaces [65]. Recently, the rise of smart homes redefined the concept of flexibility, emphasizing the role of smart devices in addressing user needs without requiring substantial modifications to domestic spaces [67]. Accordingly, as technologies evolve from being purely functional to encompassing emotional and playful experiences, a broader perspective on architectural change is likely to emerge.

2.2 The Meaning of Home in HCI and HBI

The home possesses unique significance due to its versatile role in daily interactions, accommodating a wide range of habitual activities that shape short and long-term everyday experiences [33]. In this multi-faceted environment, homes frequently evolve in their use and definition based on the needs and expectations of their residents.[83]. Prior research emphasizes that domestic technologies need to match and adapt to residents' lifestyles for effective integration within households [13].

Considering this diversity, there has been a notable increase in studies focusing on understanding the perspectives of individuals who embrace alternative lifestyles [34] and subcultures [28]. This research spans different types of housing forms such as mobile homes [74], cohousing dwellings [55], and tiny houses [77] as well as various locations in the city, including eco-homes in rural contexts [93]. Moreover, previous research highlights the importance of recognizing changing individual values at home, such as lifestyle transitions through marriage [28] or divorce [75], and the adoption of new lifestyle movements like minimalism [29]. One study even extended the boundaries of home experiences from physical to virtual spaces in a hybrid setting to address problems that users might be unable to identify in a physical environment [47].

Related research suggests that looking into these distinct contexts paves the way for developing a broader perspective on what makes a *"home"* [77]. For instance, Jenkins's [55] research on cohousing communities highlighted how the dynamic balance between public and private spaces in these living arrangements could inspire IoT design. One proposed idea, *Cohousing Radio,* offers subtle communication among cohabitants by enabling them to upload daily content that might be challenging to do in person to a shared radio channel accessible through personal household devices. This example illustrates that residents in such housing arrangements perceive home as a *"collective space"*, suggesting a need for shared infrastructures extending from the neighborhood into their individual residences.

With this in mind, there are communities that still prefer to live *off the grid* such as gated community dwellers, homeschoolers, and advocates of simple living [66]. These groups actively avoid urban infrastructures like public transportation, networked communication, and security services, thereby facing various urban boundaries. These boundaries often promote playful behavior and present opportunities for users to shape their surrounding spaces [91]. Including these additional diverse perspectives can facilitate the transition from a normative view of domestic technologies and spaces [77] to the development of multi-faceted playful directions for future studies.

2.3 Playful Interactions That Inform Spatial Changes in Home Environments

Playful interactions are defined in diverse ways, as they derive meaning from users' interpretations [50]. Prior research has introduced various frameworks to address this complexity [11, 51, 80, 98]. The Playful Experience (PLEX) framework [11] aligns closely with our research as it focuses on categorizing affordances and can be adapted to visualize playful interactions in architectural spaces [14]. Within this context, there are two key components of playful interactions: (1) users' playful approaches and (2) their end experiences. Users' approach depends on repurposing technologies and spaces beyond their typical affordances, thereby creating alternative uses [49]. For example, this might entail turning the refrigerator into a game to promote balanced meals instead of only preserving food [89]. These interactions also evoke emotions usually associated with fun [11] or positive states, such as relief or fulfillment [37].

Previous research indicates that spatial change is inherent in the nature of play. Through play, individuals create a *magic circle,* [50] that exists outside the rules and boundaries of physical space [90]. This term is often associated with *pervasive play*, where the play experience extends into the physical world [16], or the fictional world blends with surrounding physical spaces [73]. Pervasive play instances include location-based mobile exergames like Pokemon GO [84] that feature design elements transcending the magic circle socially, spatially, or temporally. [70]. Another example is the Nintendo Wii console, which allows users' living spaces to expand into the TV screen by using the game controller as an extension of their bodies [98]. This interplay between the digital and physical realms during play changes how users interact with their homes [57] through ludic activities, where they test and explore the limits of architectural spaces [85].

With play informing multiple facets of everyday domestic life through pervasive and ambient technologies [14], designing homes becomes complicated due to the diverse meanings they hold for their inhabitants [17]. Previous research has explored ways to overcome this difficulty through technological artifacts. For instance, one study speculated on a series of IoT devices that activate a playful mode when the home loses internet connection, such as a vacuum cleaner dancing around the floor or a lightbulb turning into party mode [77]. Other studies focused on deploying discovery-driven prototypes [62] to develop ludic design artifacts [38, 40] through ambiguous use and personal interpretation. In one of these studies, the researchers installed the *Table-non-table* in participants' homes, where the artifact's presence and unpredictable movements prompted them to reconsider the layout of their living spaces [46].

The Situated Play Design (SPD) approach is an overarching method that can potentially expand these design solutions. It centers on eliciting the existing playful aspects in everyday activities as *play potentials* [8], that are not primarily entertainment-oriented [8]. SPD is considered a novel approach in HCI and has been explored in various digital and physical environmental contexts such as social media [9], urban space [5], and nature [6] to speculate on designing technologies. Sicart argues that using the term *designing* falls short of capturing the essence of shaping the play [89], and proposes that designers instead become *architects of play* to craft artifact environments [24]. Thus, the potential of these interactions to drive spatial transformation presents a promising yet underexplored opportunity to better understand the nature of these associations in the HBI context [81].

3 Method

While the primary goal of architectural practice is to create physical spaces that meet the requirements of their occupants, the architectural design process often fails to fully embrace a user-centered design approach [60]. To bridge this gap, researchers have turned to human-computer interaction (HCI) methods to include users in their investigations of architectural spaces. Accordingly, we adopted a two-step user-centered approach in this study (Figure 1), with both steps implemented in Istanbul. First, we conducted a preliminary study involving semi-structured interviews with 17 technology-adopted users to grasp their needs and expectations regarding playful experiences in architectural spaces. Building on these insights, we conducted a diary study with 13 participants using the first phase of the Situated Play Design (SPD) approach [8]. The diary study resulted in a deeper and broader understanding of users' playful interactions with technology and spaces.

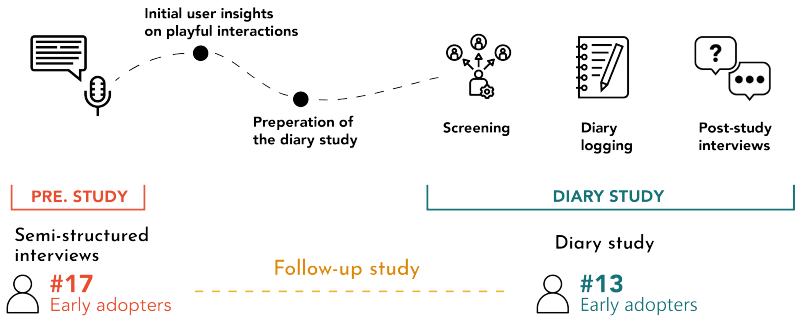

Fig. 1. Overview of the method

3.1 Gated Communities as a Case Study

Acknowledging the potential for playfulness within urban boundaries [91], we selected gated communities (GC) as our case study due to the various levels of boundaries they inhabit. Taking an approach from a spatial change viewpoint, we adopt the definition of gated communities as *urban residential developments with shared internal uses and separated from the outside by restricted access features like walls, fences, and gates [59].*

According to this definition, the first level of boundaries in GCs is the physical barriers that separate inside and outside [19]. While this segregation has been widely accepted for perpetuating spatial inequalities [19, 54, 97], the empirical data on its impact remains limited due to different geographical conditions [97] and residential typologies [1]. Hence, focusing solely on criticism overlooks residents' in-situ needs and experiences, which could be addressed through playful interactions to reduce bias and miscommunication in segregated neighborhoods [71].

Besides physical separation, GCs are exposed to a secondary level of urban boundaries due to their remote location from city life. [59]. These enclosed neighborhoods are mainly on the urban peripheries and lack access to urban infrastructures like leisure facilities and transportation [1, 18]. This deliberate disconnection from infrastructures has led Mainwaring et al. [66] to characterize GCs as self-marginalized communities, which practice a case of intentional non-use of technologies [86].

Gated communities emerged in Istanbul after the 1980s, following the introduction of new mass housing developments and natural disaster concerns [1]. Today, they still play the leading role in the housing market with an ever-growing number of users in this rapidly expanding metropolitan area [44].Among the four types of GCs apparent here, we concentrated on typical apartment blocks in horizontal gated developments [1] that serve a broader demographic, including middle and upper-middle-class individuals. While they are built near large green areas, there's room for improvement in cultivating place identity and fostering closer community bonds among residents [44]. GCs cover extensive areas designed to accommodate as many units as possible and transform into distinct peripheral urban neighborhoods that substantially impact the entire city's built environment [44]. Overall, we were intrigued by the prospect of transforming and reshaping these areas based on users' playful experiences.

3.2 Preliminary Study: User Interviews

Similar to previous studies, which are in the domain of understanding the home life of users [32, 58, 72], we conducted semi-structured interviews as a preliminary study. We began by defining the characteristics of the urban areas relevant to our research question and selected peripheral gated communities in Istanbul for our case study.

We deployed a screening survey using our institution's participant pool and employed snowball sampling through our professional networks to reach potential participants. We recruited 17 participants based on the representation of different user groups (i.e., various age ranges, living conditions, and household size). We also applied the Innovativeness Scale [52] to identify participants inclined to integrate new technologies into their lives, aligning with characteristics of being an early adopter or higher on the scale [32]. Among our 17 participants (8 male, 9 female), 52.9% were 25-34 years old, while others were 35-45 (47.1%). Only one of the participants was living alone. All other participants shared living spaces with other cohabitants: four lived with their partners(25%), two lived with housemates (12.5%), three lived with their parents/siblings (18.75%), and seven lived with their partners and children (43.75%).

The interview covered how individuals playfully interact with their daily surroundings, their current use of technology in their homes illustrated through floor plan sketches, and their expectations for playful interactions with technologies and potential architectural changes. After the interviews, we transcribed the user data to conduct a thematic analysis [25]. Two additional HCI researchers from related disciplines subsequently reviewed the findings to validate participants' responses and ensure the coherence of the final themes.

3.2.1 User Insights on Playful Interactions. Through discussions with participants, we uncovered 34 instances of playful interactions. The insights included users' habits, needs, and expectations within their domestic contexts. We also noticed that participants from different household arrangements expressed variations in playful interactions among cohabitants.

Three primary motivations for playful interactions emerged as driving forces behind architectural changes: (1) employing non-oriented fun and curiosity in daily activities, (2) enhancing new interactions or experiences through motion, and (3) reliving past experiences at home through social deconstruct. Identifying these motivations appeared crucial as they influence the expected

spatial changes, even when using similar technologies. Our findings emphasized that playful interactions in architectural spaces often involve physical or social engagements, challenging spatial boundaries, or finding alternative ways to navigate within them, which aligns with previous studies [15, 98]. These findings informed the follow-up diary study (Figure 2).

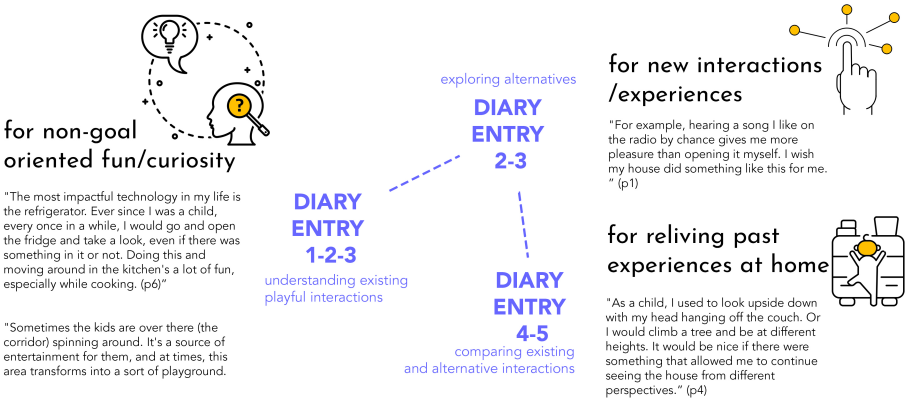

Fig. 2. How playful interactions from the preliminary study are translated into the diary study

3.3 Diary Study

Recent studies regarding Situated Play Design (SPD) aim to explore non-entertainment-based everyday activities that can integrate playful experiences with both technology and spatial interactions. Following the first step of the SPD (i.e., Chasing the Play) [8], we planned to use an observational method to uncover *play potentials*. This approach aimed to minimize researcher involvement, though some level of inclusion was inevitable, to observe everyday playful interactions objectively in participants' natural environments without interruptions.

Among the various observation methods, we employed a diary study [53] as the most fitting approach. Prior research with similar objectives in architectural contexts has found this method to yield promising results [92, 95, 100]. In particular, one study highlighted that insights obtained through diary entries were visionary and led to alternative solutions while requiring relatively low effort from both participants and researchers [95].

3.3.1 Content and Preparation of the Diary. The diary contained five activities designed to align with the insights from the user interviews and was structured into three sections (Figure 3).

In the first section (diary entry 1), we aimed to acclimate participants to the study's objectives and identify playful areas within their domestic environments. Subsequently, in the second section (diary entries 2-3), we introduced the components of technology and spatial experience into the study. We intended to capture daily playful moments by utilizing participants as observational tools and enabling them to practice investigating alternatives in familiar situations. In the last section (diary entries 4-5), our objective was to stimulate participants' exploration of alternative affordances [43] through their lived experiences. To achieve this, we initially endeavored to immerse participants in a playful mindset familiar to them by re-practicing their childhood experiences through bodystorming [87]. We gave them prompts like *"Try to recreate a childhood activity with another home member"* to facilitate their embodied thinking. Afterward, participants were encouraged to unearth alternative methods for multitasking activities through role-playing. The task included listing their activities

and correlating them with PLEX cards [11]. As the study concluded, we asked the participants to reflect on their diary process by comparing past and present experiences.

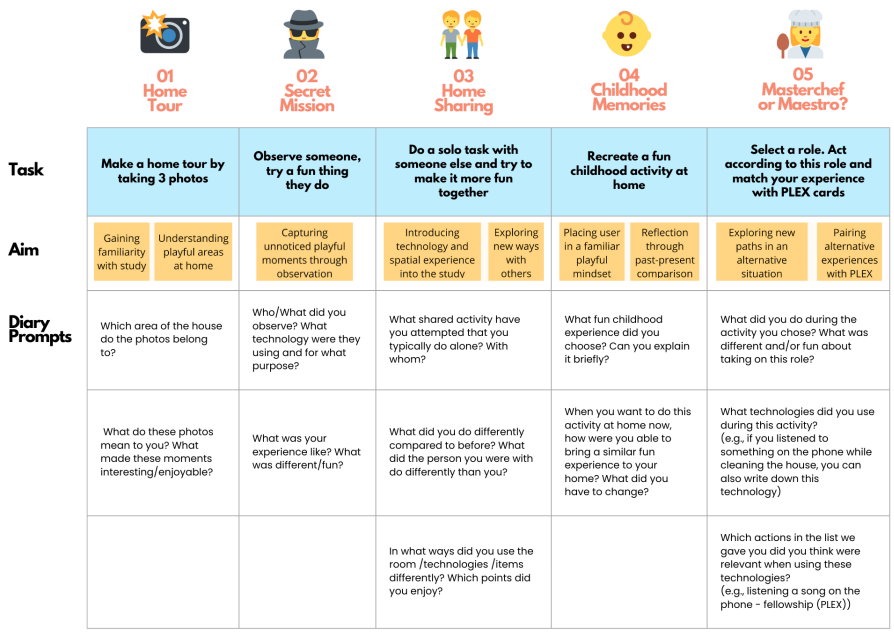

Fig. 3. Content of the diary study

3.3.2 Recruiting Participants. Similar to the user interviews, we recruited participants who live in the peripheral gated communities of Istanbul by distributing a survey through our institutions' participant pool. Within the survey, we collected data on participants' demographic characteristics and living circumstances, including details on cohabitants, residency types, and locations. We also reapplied the Innovativeness Scale [52] to determine potential participants' tendencies toward technological developments.

We received a total of 54 responses. From there, we contacted 30 potential participants based on the following criteria: (1) between the ages of 25-45, (2) living in a peripheral gated community in Istanbul, and (3) living with at least one family member. We met with all potential participants via an online platform and explained study objectives and expectations. After these meetings, 13 participants agreed to participate in the study, as detailed in Table 1.

3.3.3 Study Procedure. The study procedure consisted of (1) pilot studies, (2) finalizing the study protocol, (3) screening and recruiting participants, (4) participants' diary logging process, and (5) post-study interviews. After the diary protocol was finalized (Step 2), the remaining phases took approximately four months to complete.

The study contained five activities in three sections, to be completed within seven consecutive days. This period was sometimes extended between ten to fourteen days due to participants' availability constraints. We informed participants at the beginning of each section and sent their daily tasks separately via email. We sent a reminder email to users every three days if they had not completed the corresponding section.

Table 1. Diary Study Participants

Participant	Age	Gender	Living condition	Household size
P1	35	Male	With partner	2 people
P2	30	Female	With family (parents+sibling)	4 people
P3	31	Male	With partner + child	3 people
P4	25	Female	With partner	2 people
P5	32	Male	With partner	2 people
P6	29	Female	With family (parents)	3 people
P7	30	Female	With family (parent)	2 people
P8	28	Male	With partner + child	3 people
P9	38	Male	With partner + child	3 people
P10	27	Female	With family (parents+sibling)	4 people
P11	36	Male	With partner	2 people
P12	32	Female	With partner + child	3 people
P13	42	Female	With partner + child	3 people

We recorded diary entries via an online form to track the process. For the first activity, we asked each participant to provide at least three photographs of areas in their homes that they considered playful, along with an explanation of their choices. The other four activities relied on written diary entries based on specific prompts we provided (Figure 4). In total, we gathered 44 photographs and 122 entries. Since diary studies can be demanding for users, we only inquired about their past and current experiences in the diary logging period [53]. In the post-interviews that followed, we aimed to uncover their alternative expectations by encouraging them to ideate on future possibilities.

After diary logging, we meticulously examined each participant's entries and took initial notes for further discussion in post-study interviews. We started by asking them to reflect on their entire diary process, identifying which activities they found playful and how they managed to create playful experiences in their everyday spaces. Then, we reviewed our notes and asked for more information and clarification on the required entries. Before ending the meeting, we inquired about their expectations for spatial changes that could feed into the foretold playful interactions.

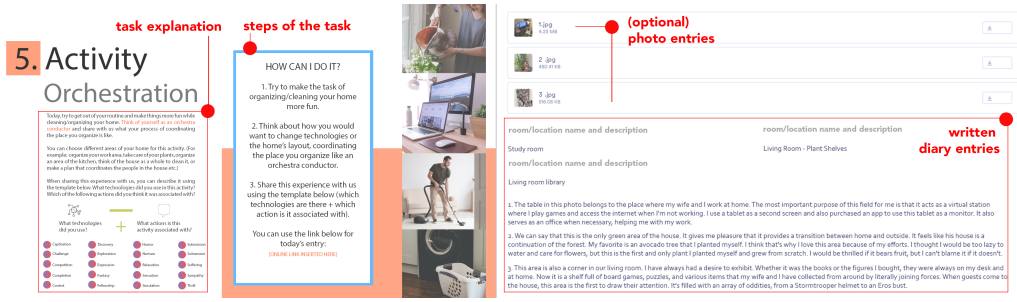

Fig. 4. Examples of diary pages and participant entries. Left: Diary page of activity 5, Right: An example of a participant's diary entry of activity 1

3.3.4 Data Analysis. We used reflexive thematic analysis [25] to interpret the study's findings based on written diary entries, which also contained participants' explanations of playful aspects for all photographs and transcriptions of post-study interviews.

After familiarizing ourselves with the data, we started coding the quotes to highlight related user insights to our research question, which led to the emergence of the initial groups. These groups were further discussed online using Miro, chosen for its collaborative visual interface, with the two HCI researchers from our research group to ensure coding reliability. These researchers, selected for their expertise and relevance to the study's scope [21], had also contributed to data analysis during the preliminary research. The first researcher has a background in architecture and four years of expertise in Human-Building Interaction (HBI), whose work closely aligns with this research's objective of exploring future changes in homes but within a historical neighborhood context. The second researcher comes from a product design background and has five years of experience in understanding technology-adopted users and their interactions with domestic technologies while specializing in Human-Food Interaction (HFI), where playful interactions are also explored.

During the first meeting, these researchers reflected on the initial outcomes and their relation to the research questions, formed new connections among the groups, and addressed potential disagreements, such as the ambiguity in interpreting respondents' statements. Ultimately, they proposed reorganizing the groups to create initial themes. They also raised concerns about the relation of some themes to the play context and whether they were clearly distinct. Consequently, we conducted two additional meetings to reflect on and validate the alignment of the initial themes with playful interactions and architectural spaces by using the PLEX framework [11]. These discussions resulted in the final refinement of the themes, categorized as *spatial play potentials* that can trigger architectural design possibilities.

4 Play Potentials For Spatial Change (SPP)

Here we present findings from the diary study and follow-up interviews (N=13), in which we aimed to reveal the everyday playful interactions of technology-adopted users concerning architectural spatial changes in domestic settings. Our analysis resulted in the identification of 12 spatial *play potentials* [8] under four overarching themes: (1) creating and expanding play-spaces, (2) balancing play and comfort, (3) intertwining imagination with spatial experience, and (4) gamifying household interactions. Moving forward, we refer to Spatial Play Potentials as SPP (Figure 5).

In the study, we observed distinct differences in how three different family arrangements experience play at home. (1) Participants living with their partners indicated a strong awareness of each other's habits and the organization of their homes. They experienced minimal surprises and often engaged in activities together to evoke a sense of playfulness, viewing their partners as *enablers* of play. (2) In contrast, participants living with parents and siblings often had divergent schedules and individual lifestyles. More often than not, they pursued individual play through imaginative reinterpretations of daily life, such as reimagining the home as a city by observing plants. (3) Participants living with their children oriented their domestic playfulness around their child's activities, noting that parenthood led to a rediscovery of the role of play in their lives. They frequently mentioned exploring everyday objects and technologies and repurposing them into play objects or spaces. Children are *facilitators* of play and change in this family setting.

4.1 Creating and Expanding Play-Spaces

When a user is in a building or room, it's not just the physical space that affects the experience. The architectural elements, everyday objects, and the overall environment also play a role. These elements are typically perceived as having specific functions, such as windows primarily designed to let natural light into a space. Aligned with this, participants shared instances where they playfully reinterpreted these established functions to create spaces designated for play. This includes bringing urban experiences into the home, continuously redefining play areas by extending or shrinking areas as needed, and using everyday elements to build play-spaces.

Play Potentials for Spatial Change

User insights from the diary study



01 Creating and expanding play-spaces

When a user is in a building or room, it's not just the physical space that affects the experience. The architectural elements and objects within their periphery of vision and the overall environment also play a role. Aligned with this, participants shared instances where they playfully reinterpreted these established functions to create spaces designated for play.

SPP1
Simulating urban-like experiences

SPP02
Expanding play across space by adjusting boundaries

SPP03
Exploring architectural elements & objects to build play-spaces



02 Balancing play and comfort

Domestic spaces are designed to offer comfort through various means, such as improving the physical, visual, and tactile aspects of the space. However, the participants revealed that engaging in playful experiences also encourages them to challenge both bodily and architectural boundaries.

SPP4
Taking risk within comfort

SPP5
Challenging the perspective shift

SPP6
Disrupting the visual comfort



03 Intertwining imagination with spatial experience

Architectural space isn't confined to its physical dimensions; it also encompasses the meaning it takes on through human interactions. Echoing this notion, when participants reflected on playful uses of their homes and explored new possibilities, they frequently communicated with their imaginations. These imaginative constructs were closely interwoven with their everyday lives.

SPP7
Reorganizing to imagine home as another space

SPP8
Imagining from a non-human viewpoint

SPP9
Incorporating collections of memories in spaces



04 Gamifying household interactions

The gradual integration of technologies to include emotions is reshaping the social dynamics within the home and blurring the boundaries between human-building interactions. Inspired by this, our participants have found ways to turn household interactions into a game by weaving playful elements into this evolving relationship.

SPP10
Forming play through random encounters and discoveries

SPP11
Interrupting the daily routine momentarily

SPP12
Shifting roles and communication feeling like a game

Fig. 5. Themes of spatial play potentials (SPP)

4.1.1 SPP1: Simulating Urban-Like Experiences. A couple of participants emphasized a growing need to experience urban life in close proximity to their homes. Being distant from the liveliness of the city center compelled them to find strategies to integrate outdoor experiences into their domestic environments. They shared a range of urban experiences, including observing situations resembling the chaos of a city, bringing the outdoor forest experience into their homes, and adjusting street games for indoor play.

Among these, P7's comment plainly illustrated this desire by describing how she observes snippets of urban life in her home: *"The plant corner here is always changing. Sometimes, there are many plants, but when the plants die, the population decreases. It generally seems like a city with a small epidemic within my home."* Participants also felt that the physical boundaries of their homes constrained them to enjoy nature, even with the presence of nearby green spaces. P5 mentioned he tried to overcome this disconnection by using a plant area in the house to create a transition between inside and outside and make it feel like an extension of the surrounding forest.

This case also extended to the participants, who simulated exciting outdoor urban activities at home. For instance, P5 mentioned his childhood enjoyment of pretending a regular chair was a car or truck and immersing himself in imaginative traffic. He found that although computer-based driving simulator games now offer a similar thrill at home, they restrict creativity in customizing spatial arrangements. In essence, participants enriched the playfulness of their living spaces by extending the unpredictable characteristics of cities and forests into their homes.

4.1.2 SPP2: Expanding Play Across Space by Adjusting Boundaries. When participants shared how they incorporate play into their daily activities, they noted that play often extends throughout the entire space rather than being confined to a specific area. These play-spaces are always open to negotiation, allowing users to redefine tangible and intangible boundaries within their residential spaces. This dynamism enables space and technology to influence and shape one another mutually.

For instance, P4 illustrated how altering the arrangement of a space could transform technology usage and change the feeling of that space to hold entertaining purposes: *"Some nights, to reward ourselves, we combine the seats in the living room and make a movie bed for ourselves for a movie marathon. Normally, I scroll through my phone while watching movies at home, but when we enter that zone, it's like being in the cinema."* In correspondence, P6 explained how using technology in a social and playful context could impact the space organization. She recounted sharing headphones with her niece while dancing to the music by clarifying, *"When the headphones created a wall between us, we switched to speakers and danced together in the whole room."* For them, switching to a different technology affected the social dynamics and the use of space.

Moreover, P5 and P6 noted that architectural boundaries do not entirely isolate one space from another. Sound and light from adjacent rooms or objects influenced their activities, resulting in a more fluid and interconnected experience within the house. For instance, P5 strategically placed lights and speakers behind his computer to enhance the sense of depth while playing games. He observed that this arrangement made the space feel more spacious and facilitated deeper immersion.

4.1.3 SPP3: Exploring Architectural Elements and Everyday Objects to Build Play-Spaces. Participants observed that play is integral to their lives, especially when their children are involved. When play is perceived as this significant, they found that anything around the house, from architectural elements to everyday objects, can be transformed into a source of play.

The participants who live with their children (P3, P8, P9, P12, P13) all acknowledged that they frequently create play-spaces, where they establish *magic circles* that distinguish play areas from non-play areas. P8 clarified that the absence or dysfunctions of household objects become irrelevant with a playful mindset. He shared his favorite childhood activity, *constructing houses*, with his

daughter. Together, they combine chairs and blankets to enhance their constructions and incorporate various household items to form the walls of their imaginative play spaces.

Additionally, architectural elements, such as floors, ceilings, windows, and doors, which play a role in forming participants' experiences of space, adapted to new play purposes depending on how users interpret and use them. In particular, P3 and P8 explained that windows held special significance, as they repurposed these elements to strengthen family bonds. P3 further explained how the window became a news feed interface for his daughter as: *"The living room's window has a significant impact on my daughter's life. She observed the surroundings, recognized the dogs around the neighborhood, and even learned the house's location. She followed every event during the day and presented us the news in the evening."*

4.2 Balancing Play and Comfort

Domestic spaces are designed to offer comfort through various means, such as improving the physical, visual, and tactile aspects of the environment. However, participants revealed that engaging in playful experiences also encourages them to challenge both bodily and architectural boundaries. This is evident in instances like experiencing different extents of risky interactions with the environment as a child and as an adult and creating unconventional combinations to infuse a sense of visual playfulness into specific areas of the house.

4.2.1 SPP4: Taking Risk Within Comfort. As participants discussed various risky and playful activities, they expressed a desire to maintain a degree of control to avoid disrupting their comfort. For instance, P2 and P11 strained away from repeating a childhood activity given as a diary task (diary entry 4), feeling that they no longer had the size or courage to attempt this.

Interestingly, two participants shared experiences involving the same technological device but from different stages of their lives. P2 recounted a childhood memory of climbing into a cold refrigerator to eat watermelon, using the entire body in a physically daring act. In contrast, P3 described using the fridge in summer to cool a pillow or occasionally putting their head inside briefly to cool down, illustrating an experience limited to the head. This comparison shows that while adults and children engage in risky play, the levels and nature of playfulness differ due to bodily capabilities.

Moreover, other participants further explained how they engage in risky play as adults. For instance, P7 described an acrobatic attempt at hanging curtains while adding thrilling physical movements for excitement. Another participant (P8) observed his wife placing their daughter on a robot vacuum cleaner, which surprisingly delighted the child instead of scaring her as the robot's voice enhanced the playful experience. These instances emphasize participants' efforts to balance enjoyment and safety in their home activities, highlighting scenarios where both coexist harmoniously.

4.2.2 SPP5: Challenging the Perspective Shift. Many participants commonly discussed experiencing their homes from different perspectives to engage in playful interactions with their surroundings. These perspectives ranged from shifting to diverse heights, such as viewing the home from the ceiling or the floor, to discovering distorted viewpoints within the house.

Encountering this shift in perspective posed a challenge to bodily limitations. P7 clarified, *"The ceiling is a surface that people generally do not contact or touch frequently. To experience this, I climbed onto a chair and stretched my fingertips upward because I wasn't tall enough to reach it comfortably. Suddenly, objects in the house appeared differently to me. This incident served as a reminder that there is a notion of height within the household, despite its often-overlooked nature."* In contrast, P8 remarked he had to turn the floor into a play area because he often needs to invent creative solutions to entertain his daughter.

Besides using architectural elements, participants also utilized household furniture to experience the perspective change. For instance, P4 mentioned that a mirror at the entrance alters proportions and creates distorted perspectives. This object creates a space where she enjoys dancing in front of it with her AirPods, discovering how her body moves within the space.

4.2.3 SPP6: Disrupting the Visual Comfort. Comfort can encompass both physical and visual aspects, offering a sense of ease regarding how something feels and appears. Aligned with this, participants mentioned disrupting not only their physical comfort but also their visual appeal.

They briefly explained how creating unusual combinations resulted in playful interactions. For example, P2 found an area of her living room playful because the antique furniture and smart technologies formed an unconventional mix that contributed to the *magic* of that place. Similarly, P5 expressed a desire to exhibit unique items in his favorite area of the house. He disclosed, *"When guests come to the house, this area is the first to draw their attention. It's filled with an array of oddities, from a Stormtrooper helmet to an Eros bust."* Both participants remarked that visually disrupting the space contributed to a sense of it being part of their identity.

4.3 Intertwining Imagination with Spatial Experience

Architectural space isn't confined to its physical dimensions; it also encompasses the meaning it takes on through human interactions. Echoing this notion, participants frequently communicated with their imaginations when reflecting on their playful exploration of new possibilities. They reimagined their homes as different environments through collections, reorganizations, and non-human perspectives. They also described how they transfer these imaginative constructs into their spatial experiences.

4.3.1 SPP7: Reorganizing to Imagine Home as Another Space. Through reorganizing the space around them, participants defined new spaces within their domestic environments. When this restructuring blended with participants' imagination, the concept of the home began to take on new meanings, like a photography studio (P3), a cinema (P4), an exhibition space (P5), or a history museum (P9). P3 illustrated this as: *"The wall dividing the kitchen from the living room serves as a stage wall for us. The light angle is quite good, so we take our photos here. Thus, the house sometimes turns into a photography studio."*

In addition to perceiving the home as a familiar space, P6 provided an example of how imagination profoundly influences physical experience through unique personal imaginary spaces. She mentioned that the gifts she purchases for her nieces often catalyze spontaneous role-play. For instance, the twisting balloons she recently bought for her nieces turned their home into an extensive playground for a balloon battle.

Apart from the physical intervention in spatial organization, certain technologies or objects also help to create a *change of scene*. P9 mentioned using the projector for ambient lighting to change the room's aura, while P4's air purifier created a colorful atmosphere by emitting surrounding colors. Even more so, both P4 and P10 mentioned feeling as if they had teleported to a concert-like environment when using objects like a hair dryer or a mirror. P4 elaborated, *"When I pretend to sing in front of the dressing mirror, it feels as if I'm on stage due to its immense scale."*

4.3.2 SPP8: Imagining an Experience from a Non-Human Viewpoint. Participants expressed interest in imagining their homes from the perspectives of non-human inhabitants. P1, P7, and P12 mentioned the unusual movements of their cats and having unexpected encounters and staring contests with them. They were intrigued by cats' non-goal-oriented interaction with technology, such as lying on a laptop keyboard while they worked (P12) or staring at speakers when hearing the incoming music (P1).

Aligned with these, P4 recently encountered an unexpected visitor: a gecko that somehow entered her home from the outdoors. This guest sparked a reflection on how the house is perceived and experienced by others, prompting her to imagine how she could integrate this understanding into her own spatial experience. She elaborated, *"Even though I hardly see the gecko moving, I find it in different places, which means it's been walking around without me noticing. Sometimes, I wish I could do the same. It would be nice to navigate spaces unseen, whether to avoid disturbing others or to cross behind a video call."*

On the other hand, P7 found fascination in experiencing the home from a technological device's viewpoint. She illustrated this by comparing the challenges of a robot vacuum cleaner getting stuck in threads and cables, where obstacles become opportunities rather than hindrances. This imagination process guided her to reflect on her daily life, considering how she navigates through her home to overcome challenges while contemplating the concept of interscalability.

4.3.3 SPP9: Incorporating Collections of Memories in Spaces. Throughout the study, participants shared experiences of infusing their homes with meaningful collections and memories and personalizing distinct spaces to showcase them. This allowed them to bring collections from the outside world into their homes, relive shared memories, and even envision shared dreams about the future.

For example, P9 emphasized making a technological device meaningful by attaching personal significance from the past. She described the refrigerator as a *"personal history museum"* where she displays magnets collected from various countries and cities to represent cherished memories. In contrast, P1 and P13 associated meaning with present and future memories. P1 mentioned placing a painting made from seashells he collected during past holidays in a strategic position as a reminder of his aspiration for a future seaside lifestyle.

One step further, P10 contemplated the implications of these meaningful items for future technologies and homes. She stated, *"Sometimes I imagine traveling through the photographs at home. In the past, when there was no technology, we kept our memories in photographs. It was the technology of those times because it was like an interface. Just like that, imbuing memories into homes can turn them into an interface."*

4.4 Gamifying Household Interactions

The gradual integration of technologies to include emotions is reshaping the social dynamics within the home and blurring the boundaries between human-building interactions. Inspired by this, our participants have found ways to turn household interactions into games by weaving playful elements into this evolving relationship. For instance, household members have explored new forms of communication when they use the home at different times and even set up new game-like experiences through unexpected and discovery-driven encounters with each other and technologies.

4.4.1 SPP10: Forming Play Through Random Encounters and Discoveries. Reflecting on their diary entries, nearly all participants highlighted that a significant aspect of the playfulness within their homes emerged from the unpredictability of stumbling upon unexpected things or encountering social situations beyond their control. This sense of unpredictability encouraged them to turn these interactions into games and imagine alternative ways to interact with technologies and their living spaces.

Participants drew connections between existing games and how household interactions naturally evolved into playful experiences. For instance, P1 explained that his communication with his cat unfolds spontaneously, *"When we meet by chance at home, we stare at each other and wait to see who will spoil it first. Sometimes, it feels like we're playing hide and seek."* A similar instance of this

game was also described by P8, where he turned the routine task of removing objects for the robot vacuum cleaner into a hide-and-seek game with his daughter.

Expanding on cleaning and tidying up tasks, P4 remarked that what is typically viewed as monotonous can lead to intriguing discoveries within the home. For example, discovering a significant dust accumulation in a particular area led her to consider whether the room's window was left open. Following these clues made her feel like a detective engaged in pursuit through increased attention to detail in objects and spatial awareness.

Encounters like this evoked how spatial changes can occur in domestic settings. P10 envisioned future spaces in detail as: *"I wish my home could offer me unexpected, playful experiences. It would be amazing if I could transform into someone else instantly. The house could change almost like a labyrinth with spontaneous changes around every corner."*

4.4.2 SPP11: Interrupting the Daily Routine Momentarily. Some participants express joy in brief, playful moments throughout the day, sometimes lasting just a few seconds. These fleeting moments felt even more enjoyable to them as they provided unforgettable experiences to cherish later.

P13 noted that she uses her coffee breaks as a chance to create little surprises for herself with the coffee machine. She explained,*"When I try a new coffee bean, contemplating how it will taste gives me a hint of surprise. Sometimes I make quick shapes for myself just for fun."* P1 shared a related experience of making cooking more enjoyable with a playful omelet-flipping gesture with his partner, which sometimes turns into a friendly competition. While this gesture does not impact the outcome, it adds a momentary sense of enjoyment to their shared experience.

Another participant drew attention to how the scale of objects impacts the duration of playful activities. She mentioned having various mirrors in her house and explained that her interactions with them vary depending on their size. With small mirrors, she tends to engage in brief and silly moments, such as making funny faces to generate a quick sense of humor.

4.4.3 SPP12: Shifting Roles and Communication Feeling Like a Game. When talking about household interactions, participants described that specific roles within their homes evolved due to their interaction with technology. They included objects as members of their house and, in some cases, even discovered new modes of communication as household members endeavored to communicate non-simultaneously.

One side of this shift was the addition of a non-human to the social circle at home. P5 mentioned that when cooking together with his partner, music becomes a part of the experience as they place the speaker on the kitchen cabinets to amplify the sound. He noted that the speaker has become almost like a third member of their household. Likewise, P10 referred to how her mom's concert magnets consistently accompanied them to every new house they moved into, always finding their place as favorite objects on the refrigerator.

The other part of this shift concerns the changing communication dynamics. One participant (P11) expressed discomfort with having over 200 unknown neighbors. To overcome this, he adjusts his schedule to encounter familiar faces, such as a man who walks his dog in the park at the same time each morning, making this person almost like an extended household member. Additionally, participants living with their parents and siblings (P2, P6, P7, P10) noted that each household member has distinct active hours at home. P2 took this as an opportunity to speculate on the future evolution of homes as: *"If our home were like a clock showing everyone's active hours, it would probably show that the times we use the house as individuals are quite different. Then, maybe the house could become a space where we all communicate at different times."*

5 Discussion

Spatial Play Potentials (SPP) revealed users' playful interactions with domestic spaces and technologies. To make sense of SPP, we first reviewed the literature on emerging technologies, design artifacts, and architectural designs that incorporate playful interactions in home settings. This helped us outline a preliminary design space, which is a metaphorical landscape of curated ideas and concepts [39] explored through design activities [35]. Using this preliminary design space as inspiration, we used sketches [45] to develop and discuss architectural design ideas. While generating these ideas, we also ideated on technologies, recognizing that playful interactions catalyze reciprocal changes between technologies and spaces.

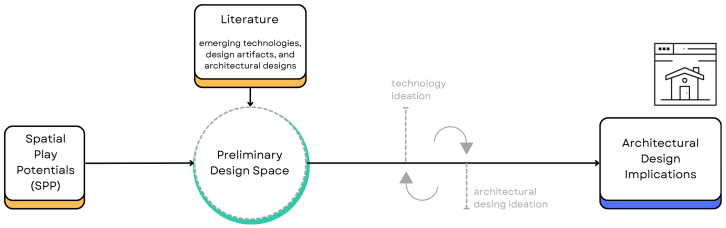

Fig. 6. Roadmap for how SPP can be used to form architectural design implications

Following the roadmap shown in Figure 6, we present the initial design space through three design implications (DI): (DI1) tailoring spatial flexibility for shape-changing playful interactions, (DI2) embedding communication variability in the home structure, and (DI3) turning home into a playmate by shifting the use of architectural elements.

5.1 Tailoring Spatial Flexibility for Shape-Changing Playful Interactions

Study findings indicate that playful interactions with technology may require adaptable spaces accommodating users' dynamic movements. Participants actively sought experiences that interchangeably challenged their bodily limits (SPP4) and home boundaries (SPP2, SPP5) to extend playfulness to the physical space. Activities like attempting to touch the ceiling with improvised movements (P7) or navigating a baby around the house on a moving robot vacuum cleaner (P8) underscored the necessity of adjusting spatial comfort to coexist with playful risks (SPP4). This intersection of embodied and peripheral activities within domestic spaces suggests the need for a new understanding of flexibility in spatial design driven by playful interactions.

Embracing discomfort within the comfort of home environments offers a potential avenue to meet this requirement, potentially compensating for risky activities. *Architecture Against Death*, a concept pioneered by Shusaku Arakawa and Madeline Gins, advocates for domestic spaces to have an *uncomfortable existence* to enhance residents' mental and physical stimulation [30]. Their design method involves avoiding sharp corners, using asymmetrical shapes, and offering changeable elevations to create an evolving interaction between residents and their environment. Building on the idea of using discomfort as an architectural parameter, we envision the home becoming an interactive play space in which the architectural elements serve as interaction modalities. For instance, floors could become interactive canvases responding to user movements. They might display images to enhance playful activities like *The floor is lava*, where players navigate space by avoiding the ground surface [63]. This transformation could extend through the space via mobile modular furniture and architectural elements equipped with embedded sensors.

Another considerable approach involves exploring the increasing role of shape-changing objects in architecture [82]. Recent advancements in shape-changing materials that can alter physical properties like rigidity, temperature, or texture introduce new possibilities for systems responsive to bodily movements and rhythms [56]. Studies integrating shape-changing technologies into home environments often feature items of furniture, such as a stool adjusting shape based on surrounding light movements [102] and tables adapting to the weight of items on their surfaces [41, 101].

The desire for shape-changing flexibility also extends to users seeking urban-like experiences within home comfort (SPP1), as illustrated by a participant (P7) who enjoyed observing glimpses of urban life through an uncontrollable plant area at home. This opens up a potential for rethinking how urban artifacts can be situated within domestic spaces, particularly in gated communities with limited urban exposure [91]. Paek's *Self-Sustainable Chair* [79], a dress that transforms into a chair through user movement and requires walking to re-inflate, exemplifies how shape-changing technologies can redefine spatial experiences by integrating playful bodily engagement. While considering wearables as a means to transform an entire space may seem implausible, this discussion holds unique potential to perceive space as an extension of the body rather than simply a backdrop for its movement. Wearables could blend users' perceptions of rooms, homes, and surroundings with a pervasive play approach. We foresee the development of flexible networked hybrid shared spaces within gated communities facilitated by personalized wearables. These communal hubs, situated between windows or along building façades, could serve as gathering and socializing spots while enabling playful interactions with interior spaces and structures that dynamically reconfigure as residents move within their homes.

5.2 Embedding Communication Variability in the Home Structure

Users' playful interactions within the house are shaped not only around the individuals but also through shared experiences. In the study, we examined three different family dynamics and observed that household members establish unique connections through communication, varying with each family structure (SPP10, SPP12). These connections impact the overall peripheral experience and prompt architectural changes.

Participants living with their parents and siblings noted that when household members have independent schedules and may not interact in person for several days, they resort to non-simultaneous communication methods to stay connected (SPP12). To facilitate this continuity, one participant (P2) proposed restructuring the home environment to resemble a clock-like mechanism (SPP12). This idea aligns with prior research on the reappropriation of everyday objects [10, 38]. Echoing P2's idea, one study speculated on transforming a regular coat rack into a device that adjusts the home's digital connectivity based on the presence of family members at home [77]. Previous research also demonstrated how such connections might spark new uses for technologies and spaces, like *Lyssna*, which modifies the fridge's soundscape based on foods' attributes like freshness or sweetness [76].

Moreover, participants also identified unique ways to connect with household objects, mentioning technologies that create momentary surprises (SPP11), invoke memories (SPP9), or reshape social dynamics (SPP12). One participant envisioned incorporating memories into the home's fabric by utilizing photographs to display meaningful moments (SPP9). We see this as an opportunity to reimagine the home as a means for temporal, non-simultaneous communication. Through AI integration, homes could adapt to each inhabitant's activities, with walls serving as interactive interfaces that capture and display photographic moments throughout the day. For instance, a father returning home could encounter the space as his daughter experienced it earlier and *virtually relive* those moments through the evolving wall configurations. This exploration of non-normative communication styles holds promise for fostering deeper and more playful connections with domestic spaces, particularly in understanding how information flow influences home infrastructure.

5.3 Turning Home into a Playmate by Shifting the Use of Architectural Elements

User insights exhibit that home is not seen as just a space to live within but an entity for interaction. The built environment actively drives change within this dynamism, starting from its fundamental components. By designating spaces for play, the affordance of architectural elements such as windows, walls, and floors (SPP3) can be reimagined, and even the structural norms can be challenged [96] through perspective shift (SPP5).

Participants identified architectural elements that connect the home to its surroundings, like windows and doors, as potential play objects. For instance, one participant recounted how their daughter transformed a window into a personal news feed, using daily observations as conversation starters during family time (SPP3). Similarly, Milligan et al. [69] coined the term *dooring*, suggesting alternative perspectives on the door and exploring its potential. The concept is rooted in Pallasmaa's definition of the door as *the handshake of the building*, which symbolizes invitation into the home or exposure to urban life [78]. Expanding on this idea, we speculate that doors may take on unexpected characteristics in response to playful potentials (SPP10). For example, the keyhole might unpredictably shift position when a user wants to invite a neighbor in. Likewise, we propose reimagining windows as *the handwave of the building*, inspired by Pallasmaa's concept, to foster the personalization of place identity among gated community residents.

Interior architectural elements such as walls, floors, and ceilings are also expected to transform based on participants' desire to incorporate multi-sensory qualities. For instance, reflecting participants' interactions with non-humans (SPP1, SPP12), a recent study reimagined walls as conversational interfaces to communicate with plants [42], converting auditory communication into text-based interactions. Another study showcased the floor evolving into a playful architectural feature with an interactive device designed to enrich walking with thoughtful interaction [36]. Analogous to participants envisioning their homes as other spaces (SPP7), implementing this mechanism is reported to create a feeling of strolling through a forest in slow motion. These insights highlight the necessity of exploring architectural elements from a playful perspective to foster novel interaction modalities with homes and their surroundings.

5.4 Future Directions for SPP Beyond Gated Communities

Literature often takes a critical stance toward gated communities, condemning them for contributing to spatial inequality, ethical concerns regarding segregation, and urban sprawl [19, 54, 97]. Despite these criticisms, the population of gated communities in Istanbul is growing [44], particularly as a dominant form of housing development in peripheral urban areas. While these neighborhoods generate isolation, the residents may not necessarily embrace a *gated mindset* [12], indicating a potential for broader engagement and inclusivity within these spaces. As play provides an interplay between people, spaces, and objects, [71] incorporating playful components in such residential areas may expand architectural design possibilities [20] and foster a more inclusive environment [71].

Since architectural entities are interconnected with their surroundings [99], we inevitably encountered in-situ and location-based experiences in the study. For instance, residents expressed a strong desire for urban-like experiences and spontaneity at home, driven by a sense of detachment from urban life (SPP1). Additionally, frustration with sharing the neighborhood with numerous unfamiliar neighbors led residents to seek playful communication strategies within the community (SPP12). Our findings also revealed broader themes that may apply to similar apartment block typologies across urban contexts, such as the need to balance play and comfort (SPP4) and the integration of imaginative constructs with spatial organization (SPP7). These insights draw attention to human ergonomics and mental well-being, which transcends specific spatial contexts.

In summary, our discussion on three design implications (DI) has provided initial remarks on using SPP to inform architectural design ideation. We anticipate that while the overall architectural structure may undergo subtle changes, there is an opportunity for extensive minor revisions in spatial reorganization. *Minor changes* may arise from users' adaptability expectations as the understanding of flexibility in architecture broadens to encompass playful contexts with shape-changing or wearable technologies. These transformations may also address users' desires for their homes to become playmates through multi-sensory technologies. Conversely, the differentiation of communication suggests potential *major changes* within the infrastructures to enhance the overall design of homes and neighborhoods.

In essence, this study is an initial step towards establishing a definitive design space of architectural change through playful interactions. We recognize that providing a clear direction for playful design is challenging, as the meaning of play is shaped by its users [50]. Therefore, we recommend that future studies adopt a collaborative design approach, encouraging architects and designers to create open-ended designs that foster user-driven playful interactions within domestic environments. To achieve lasting change in the long term, these designers should maintain an ongoing dialogue with diverse stakeholders, including urban planners and policymakers.

6 Conclusion

This article aimed to reveal the play potentials of everyday interactions with technologies and domestic spaces to inform architectural spatial changes. To investigate this inquiry, we conducted an in-depth exploration of technology-adopted users' daily playful interactions using preliminary user interviews (N=17) and a diary study (N=13). Our contribution is two-fold: (1) We identified 12 spatial play potentials (SPP) under four overarching themes based on users' interactions with technologies and spaces. (2) We proposed three design implications that translate SPP into architectural knowledge, offering potential avenues for spatial changes.

Revisiting our initial research question, we briefly looked into potential architectural spatial changes influenced by technology-adopted users' playful interactions. Upon this, we foresee that *minor changes* in spatial layouts may be able to meet users' needs for adaptable, multi-sensory homes with playful interactions as the concept of flexible housing expands to include shape-changing and wearable technologies. Moreover, the diversification in playful communication indicates possible *major changes* to improve the overall design of homes and neighborhoods.

These findings provide an initial perspective into possible architectural changes. Future research trajectories necessitate collaboration between architects, design researchers, and policymakers to form a comprehensive design space with architectural design possibilities. To our knowledge, this is the first study to reveal potential pathways for location-based spatial changes for technology-adopted residents, with playful interactions at its core. We believe that our work lays the foundation for exploring new architectural design schemes that integrate emerging technologies into domestic spaces and make playful experiences a fundamental part of everyday life.

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