

Digital Knick-Knacks: Standalone Audiovisual Digital Possessions or Embellishments in Digital Environments

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ABSTRACT

Inspired by physical possessions displayed in the home, we define “digital knick-knacks” as standalone audiovisual digital possessions or embellishments contained within non-game digital environments. “Neko”, a cat that chases the cursor, is a historical example. We propose a taxonomy to define and generate digital knick-knacks based on key publications on consumer behaviour and personal possessions, augmented by results of a brainstorming session with 9 HCI researchers. Using the taxonomy, we prototype three classes of digital knick-knack exemplars: an ambient noise machine, a virtual pet, and a virtual picture frame. In a 10-day diary study, 10 participants design their own variants of the prototypes, and report on their experience using them on a personal device. Our analysis shows how digital knick-knacks can bring value to users, and we suggest implications for designing playful digital embellishments.

CCS CONCEPTS

• **Human-centered computing** → **Interactive systems and tools.**

KEYWORDS

digital possessions, personalization, playful user interfaces

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1 INTRODUCTION

The exploration of computer capabilities in early graphical user interfaces resulted in numerous playful and creative features, such as interactive characters (e.g., Neko [15], a cat that chases the mouse cursor¹), screensavers based on procedural drawing code, playful mouse cursors (e.g., Windows XP dinosaur cursor [55]), custom ringtones and notification tones, playful virtual agents (e.g., Clippy [54]), and virtual pets. We refer to features like these as

¹Neko can be traced back to an original PC-98 version created by “<tenten> & naoshi” around 1988 [56].

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digital knick-knacks (DKKs for short), which we define as standalone audiovisual digital possessions or embellishments contained within non-game digital environments. By “contained”, we mean that digital knick-knacks are “exhibited” ([80]) or ‘on display’ in the digital environment in a way that the user can continually choose to interact with them.

Modern user interfaces have moved away from including many DKKs like these. One potential reason is that certain examples of historical DKKs were considered “childish”, “gimmicky”, or otherwise unsuitable for professional environments [71, pp. 175–176]. The trends of minimalism, “digital detox”, and so on, are another potential reason, because they have led to favouring simpler designs and possibly fewer user customization options; for example, “flat” UI rather than skeuomorphism.

We suggest that the sterile and minimal designs of modern digital environments might not always be conducive to supporting our emotional well-being, perhaps similar to how old-age homes without an occupant’s personal furniture have been described as a “destruction of [the] self” by eliminating part of one’s identity embedded as memories in the furniture [17]. In the same way that personal physical possessions on display in one’s home or office environment can bring emotional value to their owners, through this work, we show that introducing DKKs into digital contexts can do the same.

Digital possessions are generally defined to include items such as music files, documents, text messages, and software. Past work on digital possessions focuses primarily on their collection practices (e.g., [78, 80]), designing them to be cherished (e.g., [32]), and on virtual goods in video games (e.g., [35, 79]). Past work on personalization [7] and in psychology [58] has shown that when people make something themselves, they perceive the object as having greater value. In contrast with past work on digital possessions, but motivated by the potential value that self-made possessions can provide for their owners, we focus on investigating DKKs that are ‘on display’ for extended periods of time within other non-game software contexts, and for which users have control over the design.

To understand the range of possible DKK types, what types users most value, and to support their design, we create a taxonomy by synthesizing work from the areas of meaningful personal possessions [17, 67], motivations for personalization [65], consumption behaviour [53], and the “extended self” [4, 75]. We conduct a brainstorming session with 9 HCI researchers to generate example DKKs in the context of mobile phones and desktop computers, by using the dimensions and categories from the theories in the taxonomy. From this session, we characterize 11 types.

We then design and implement three types of DKK templates as a form of technology probe: an ambient noise machine, a virtual pet, and a virtual picture frame. In a 10-day diary study, 10 participants each design their own variant of one of the templates, and report on their experience of having it on their personal computer. Based on a qualitative analysis of the diary entries and post-study interviews, we characterize perceptions of DKKs, learning that they are capable of bringing joy and providing emotional value. From the analysis, we produce a series of design implications.

The main contributions of this work are a DKK taxonomy, comprising connections between past theoretical works and DKK design examples based on a brainstorming session, and a categorization of DKK types; and considerations and implications for the use and design of DKKs, based on a diary study using exemplar DKK design templates.

2 BACKGROUND AND RELATED WORK

Our work primarily sits between the areas of digital possessions and personalization. DKKs are like digital analogues of physical possessions, yet they are not embodied in files like photos and music, and DKKs can be seen as a kind of personalization, yet are standalone entities rather than modifications to an existing system. We also outline related work in the areas of physical possessions and consumer research.

2.1 Meaningful Possessions and Consumption

There is a plethora of research on the role and value of people's physical possessions, from areas like anthropology, psychology, and consumer research. Csikszentmihalyi and Rochberg-Halton's seminal work [17] investigated the role of cherished objects in people's households through a large-scale interview study. Richins [67] also investigated people's possessions, distinguishing between "personal meanings" and "public meanings". Belk defined the notion of the "extended self", that possessions form a significant part of people's identities [3]. A more recent follow-up work [4] revises the concept for a "digital world", accounting for considerations such as the lack of materiality of digital goods and the ease with which they can be reproduced and shared.

There has also been work focused on an office work context. Elsbach investigated how non-territorial workspaces or "hot desks" were perceived as an identity threat [23], highlighting the value of personalizing work environments. Wells investigated the types of personal items displayed at work and reasons for displaying them [49]. Tian and Belk used the notion of the extended self as a lens for understanding employees' perceptions of possessions at the workplace [75].

In addition to the work on the extended self, consumer research has also focused on the role of personal possessions. McCracken [53] discussed the movement of meaning between the world, consumer goods, and consumers themselves. Some consumer research specifically investigates the digital context. For example, Lehdonvirta [46] characterized the benefits of virtual goods and related social structures, and Denegri-Knott and Molesworth [21] proposed a taxonomy for "consumption-like experiences" in online spaces.

While these works mostly focus on physical possessions, we borrow ideas from key works in our DKK taxonomy.

2.2 Digital or Virtual Possessions

A number of works investigate or characterize digital possessions. Cushing [18] defines digital possessions as "digital objects/items that individuals *recognize* as theirs". Digital possessions can include items such as photo and music files, documents, text messages, websites, software, and video games. The terms "digital" and "virtual" are often used interchangeably; however, work in the area of digital virtual goods emphasizes the distinction, using the term "virtual" to refer to being imaginary as opposed to real and material, and "digital" to refer to being computer-mediated [21]. We use the term "digital", except in the context of "virtual pet" because it is already an established term.

Some works focus on describing the characteristics and properties of digital possessions. Cushing [18] defines and characterizes digital possessions based on participant interviews, such as how digital possessions represent an individual and are perceived as having value. In a law context, Fairfield [24] describes how virtual properties and real properties share the characteristics of "rivalrousness" (i.e., exclusive control), "persistence", and "interconnectivity". Odom et al. [62] discussed "experiential qualities" of virtual possessions: "placelessness" (accessible from anywhere), "spacelessness" (not taking up physical space), and "formlessness" (being easily reproduced). In contrast, the 'on display' nature of DKKs is one of their key defining features compared to other types of digital possessions such as music or photo files. DKKs go against the grain of conventional digital possessions by trying to have a place, space, and form. More specifically, they have a place, in that they are installed on and associated with only one computer, they take up (digital) space, in that they consume screen real-estate, and they have a form, in that they are designed uniquely by and for their owner. If a DKK design leans too far into embracing the digital (e.g., cloud saving), it may limit the perception that it is primarily an object to be displayed.

Some works focus on collecting, archiving, and hoarding digital data; for example, investigating physical and digital artifacts that are part of the home archive [42], investigating digital possessions in the cloud [60], connecting past theories of materiality to digital collecting [51], and characterizing digital data preservation practices [78]. Watkins et al. [80] developed a taxonomy of digital collections, and found that "digital collections were less socially visible" than material collections and that "lack of curation can make such displays less meaningful". Many works focus specifically on the context of video games, investigating motivations or factors for purchasing in-game content [13, 34, 35, 52, 72, 82] or experiences associated with in-game content [26, 79, 81].

Following in the footsteps of Csikszentmihalyi and Rochberg-Halton, there is also work investigating cherished digital possessions; for example, understanding the experience of "ownership" of digital goods [20] and understanding teenagers' use of physical and virtual possessions [61, 63]. Going a step further, some works focus on creating interactive "hybrid" ([42]) physical objects with digital aspects, to investigate how to imbue materiality into technological things [5, 44] or design possessions that are more

cherishable [31, 32, 66]. Such works could be considered forms of DKKs; however, they blur the line between what is a digital versus physical knick-knack.

Within the sustainable design community, some works investigate how it may be possible to reduce the “rate of product consumption” by designing technological possessions that people are more attached to [64]. A seminal design philosophy work in this space is Verbeek’s book *What Things Do* [77], which proposes the notion of “culturally durable objects”: there are ways to design products to which people develop an attachment that need not “aim at ‘devotion’”. Other works in HCI propose design suggestions [59] and hybrid technological object designs [2, 64] in pursuit of this goal. While sustainability is not the focus of our work, DKKs may be able to support sustainability because of the emotional value they provide and their association with a particular device. These properties could discourage purchasing a new device with similar functionality, and avoid disposing of a device that contains one’s DKK.

Overall, past work on digital possessions focuses on incorporating physical and digital components into designs, designing possessions that people become more attached to, or on conventional digital objects like photos and music files, which are most often stored away. In contrast, our focus on DKKs emphasizes their ‘on display’ nature and specific focus on designing within fully digital spaces.

2.3 Software Customization and Personalization

Much of the literature on personalization focuses on automated methods or digital content recommendation (e.g., [27, 73]), which is not relevant in the context of our work. Instead, we consider a broader definition of personalization: “a process that changes the functionality, interface, information content, or distinctiveness of a system to increase its personal relevance to an individual” [6]. A form of personalization relevant to DKKs is what Fan and Poole refer to as “architectural” personalization [25], with the goal to “create a functional and delightful [system] environment that is compatible with a sense of personal style”, or what Marathe and Sundar call “customization”: “letting users themselves modify some aspect of an interface to a certain degree so as to increase its personal relevance” [50]. Campbell [14] also uses the term “customization” to refer to this process, and distinguishes it from the concept of “craft consumption”, in which “the consumer must be directly involved in both the design and the production of that which is to be consumed”. We see the design of DKKs as straddling the boundary between “customization” and “craft consumption”.

Several works investigate the role of personalization in this context of “customization” or “architectural” personalization; for example, relating personalization behaviours to self-determination theory [65], investigating the role of personalization on attachment to phones [76], and showing that the feeling of control and identity are supported by customization [50]. Blom and Monk [7] developed a theory of personalization of appearance of computers and mobile phones based on a series of discussion groups and interviews, explaining reasons for initiating and effects of personalization. One key result was how personalization supported “a feeling of attachment toward the device”. This is related to the

notion of the “IKEA effect”, that there is an “increase in valuation of self-made products” [58]. While DKKs could be considered a form of personalization, they are standalone, or perceived as an addition to rather than modification of an existing system. DKKs could also be characterized as digital possessions, which means that they may have unique properties not captured by work focusing exclusively on personalization. Based on the results of Blom and Monk and the notion of the IKEA effect, we propose that enabling users to design their own DKKs may provide greater value.

3 DIGITAL KNICK-KNACK TAXONOMY

To develop a range of ideas for DKK designs and an understanding of their different types, we created a taxonomy of DKKs. The objective was not necessarily to suggest a minimal spanning set of design dimensions or categories, but rather to form a resource for generating designs. The taxonomy has two parts that each characterize DKKs in separate ways. First, we synthesized a selection of influential theoretical works from four related areas (Table 1), with the goal of using these works to serve as provocation for designs. We conducted a brainstorming session with HCI researchers, which enabled us to generate a large, diverse set of feasible DKK design examples, and form direct connections between theoretical works and the design examples. Second, we categorized the generated examples into “types” (Table 2), which can serve as design inspiration for future DKKs, and which supported our DKK design templates. Appendix A summarizes examples from the brainstorming session, along with their corresponding theoretical work and DKK type.

We selected the theoretical works because they are influential in prominent research areas about personal possessions. We include works that primarily focused on physical objects and possessions, because unlike conventional digital possessions, these are often put on display, so we hoped they would be useful for generating novel designs for ‘on display’ digital possessions. Table 1 lists the selected theoretical works, categories, and dimensions, along with descriptions where the meaning is ambiguous. Below, we explain the reasons for selecting each work in more detail.

Physical Possessions in the Home. We include the “meaning classes” from the seminal work by Csikszentmihalyi and Rochberg-Halton [17], which investigates cherished possessions in the home, as well as similar work by Richins [67]. Because there is considerable overlap between the categories from these two works, we combine them into a single set of nine categories. From Csikszentmihalyi and Rochberg-Halton, we additionally include the three “purposes” and two “modalities” of possessions, and from Richins, we include three possession value dimensions. We include these works to consider how different types of and values placed in physical possessions might be applied to DKKs.

Personalization Motivations. Oulasvirta and Blom [65] relate personalization behaviours to self-determination theory, producing categories describing motivations for personalization. We include this work to consider the roles that DKKs might play as a form of personalization.

Consumption Behaviour. McCracken [53] proposes “world to good” and “good to consumer” meaning transfers. We include the

four “rituals” associated with “good to consumer” meaning transfers, to consider the ways that people may wish to interact with DKKs.

Extended Self. We include two works pertaining to the notion of the “extended self” [3]: work by Tian and Belk applying to understand possessions at the workplace [75], and more recent work by Belk that revises the concept for a “digital world” [4]. We include these works to consider how DKKs could be designed to more meaningfully become part of people’s identity. We include both of these works because Tian and Belk’s work is focused only on a work context but provides concrete categories for how the self is extended, whereas the Belk’s work is more general, but proposes more abstract categories that may be harder to use as design inspiration.

3.1 Brainstorming Session with HCI Researchers and Digital Knick-Knack Types

We conducted a brainstorming session with 9 HCI researchers (7 male, 2 female) pursuing Master’s or PhD degrees at our institution, with the goal of developing example DKK design ideas based on the design dimensions and categories from the selected theoretical works. We recruited HCI researchers because they have experience translating abstract theories and concepts into feasible design artifact ideas. Participants were 22–33 years old (mean 28), with an average of 4 years (SD 2 years) combined research and industry experience in HCI or UX.

The one-hour session was held over videoconferencing software, using a shared digital whiteboarding tool for collaboration. Participants were provided with our definition of a DKK and examples

Table 1: Selected theory categories and dimensions, including an example design generated from each theory.

Theory	Theory Category/Dimension	DKK Example	
Csikszentmihalyi & Rochberg-Halton and Richins Categories	Memories e.g., being a memento	Memories: Show a memorable photo from a year ago	
	Associations e.g., being a gift		
	Experience e.g., supporting relaxation		
	Intrinsic Qualities of Object e.g., being unique		
	Style/appearance e.g., being fashionable		
	Utilitarian e.g., enhancing efficiency		
	Personal Values/Identity e.g., embodying an ideal		
	Interpersonal Ties e.g., representing or facilitating them		
Csikszentmihalyi & Rochberg-Halton Dimensions and “Modalities”, and Richins Dimensions	Financial Aspects e.g., being valuable	Differentiation: Visualization for comparing friends’ screen time	
	“Personal”, “Social”, and “Cosmic”		“Cosmic” refers to people and the natural world
	“Differentiation” and “Integration”		standing out or fitting in
	“Instrumental” to “Symbolic”		e.g., computer vs. diary
Oulasvirta & Blom Individual and Social Motivations	“Ordinary” to “Prestige”	e.g., dog to mink coat	Emotional Expression: System that plays background music based on mood
	“Necessities” to “Recreational”	e.g., money vs. golf clubs	
	“stabilization”	alignment to cognitive capabilities	
	“interest”		
	“exploration”		
	“differentiation”	skill acquisition	
	“emotional expression”		
McCracken “Rituals”	“ego-involvement”	management of others’ impressions	Exchange Rituals: Digital postcards
	“identity expression”		
	“territory marking”	e.g., reserving a desk space	
	“exchange”	e.g., gifts	
Tian & Belk Concepts	“possession”	e.g., showing off	Possessions for Play: On-screen virtual pet
	“grooming”	e.g., preparing for an event	
	“divestment”	e.g., redecorating to remove previous meaning	
	“prosthetic possessions”	e.g., computer keeping track of user’s calendar	
	“atmospheric texture”	e.g., making white noise with fan	
	“identification with corporate self”	e.g., gifts given to employees	
Belk Concepts	“sense of past and sense of future”	e.g., photos of past experiences	Sharing: Public display of how much time one has spent time in each app
	“possessions for play”	e.g., candy dispenser collections	
	“work self and home self”	“possessions that extend the home self into the workplace”, such as family photos	
	“dematerialization”	digital possessions lack material analogues	
	“reembodiment”	ability to represent different “selves”	
	“sharing”	e.g., loss of control over information online	
	“co-construction of self”	e.g., comments from others on personal photos	
	“distributed memory”	e.g., digital clutter	

Table 2: DKK types and descriptions, with an example of each from the brainstorming session.

Type	Description	Example
Meaningful Media Display	A display of imagery (e.g., photos) or text (e.g., quotes) that is of value to the user (e.g., triggers memories, conveys a mood or personal interest)	Display of photos from one year ago
Informatic	An interactive visualization of data about oneself (e.g., number of steps walked), the computer context (e.g., how much time spent in app), non-personal generic information (e.g., phase of the moon), or data of no immediately obvious utilitarian value (e.g., number of pieces of bubblegum chewed)	Visualization of how often commands are used in an application
Help/suggestion System	A non-anthropomorphic system that helps the user learn how to do something in another application (e.g., where the tool options are) or recommendations for content or activities (e.g., 'suggested recipes', 'add a profile picture')	Display of recipe suggestions
Self-representation	A display representing the likeness or achievements of the user (e.g., avatar, virtual award indicator)	Badge representing gameplay achievement
Playful Notification	A brief playful sound or visual triggered by an external action	Sound effect upon bank transactions
Automation	A control that performs an automated task for the user	Button to automatically open applications for a particular work task
Calendar Events/Reminders	A representation of the user's calendar or reminders that were scheduled by the user themselves	Calendar month view
Embedded Game	A minigame or interactive game-like toy that is displayed under certain circumstances	Game that can be played as a reward for completing tasks
Note-taking	A place for a person to write text for later access	Digital movie-watching journal
Soundscape	A system that plays music or ambient sounds (e.g., white noise) continuously in the background	System that plays ambient coffee shop sounds
Virtual Assistant/Pet	A virtual agent representing something other than the user (e.g., digital pet dog, chatbot)	Personal assistant that provides encouragement

of relevant contexts (e.g., including desktop and mobile screens, excluding physical spaces). For each of the 7 selected sets of dimensions from the theoretical works, we explained the dimensions and then participants were given 4 minutes to generate corresponding ideas. Participants were told that they could provide generic or personal examples. After developing ideas individually, participants were given an opportunity to share their ideas with the rest of the group.

During the session, the participants generated 144 design examples. Examples were primarily in the form of brief textual descriptions, but one participant also used images to describe an idea. We excluded 36 examples for not satisfying the “standalone” requirement. For example, some ideas focused on changing colours, themes, or features of existing applications. This resulted in a total of 108 design ideas. Note that the generated examples are not necessarily intended to be novel. Rather, the goals of generating examples were to understand and characterize what types of DKKs people might value or find useful, understand what kind of functionality might be possible in the form of a standalone digital possession or embellishment that is on display, and serve as a design resource and inspiration for the creation of DKKs.

We categorized the examples from the brainstorming session into 11 types of DKKs, described in Table 2. To construct the types, the first author inductively coded the examples using a form of manifest inductive qualitative content analysis [22], which resulted in 21 types. Through discussions with the second author, we refined the types into the final 11 types (e.g., by merging different variations

of informatics displays). This approach is similar to past work that has produced taxonomies based on brainstorm data (e.g., [36]). We see this type categorization as a valuable starting point for DKK designs to address many common use-cases.

4 EXEMPLAR DIGITAL KNICK-KNACK DESIGN TEMPLATES

To continue the study of DKKs more closely, we created a set of design templates to prototype. We created multiple designs to be able to investigate a variety of types and modalities. We use the term “template” to refer to how the designs concretely implement one of the DKK types from the taxonomy, while intentionally keeping aspects of the design and contents open for control by the users. For the templates to both serve as design exemplars and as a technology probe for understanding people's feelings towards DKKs, we have the following design goals:

1. *Playful* – We focus on non-utilitarian, playful kinds of DKKs, to investigate how we might be able to bring back some of the playfulness of historical DKK designs without the perception of being gimmicky or childish. This focus also narrows down design options by excluding utilitarian DKK types.
2. *Personal* – In the same way that physical possessions are valued because they are personally meaningful [64] or designed by the owner [58], we focus on DKKs that can be made personal via user-configurable design and content options. This means focusing on DKK types with many aesthetic configuration options (e.g.,



Figure 1: Example renditions of the three exemplar DKK design templates.

an artistic decoration rather than a content recommendation system).

3. *Not distracting* — Playful DKKs need to be able to provide value while remaining unobtrusive when the user is working. Designs need to be effective even while occupying a small screen area.
4. *Diverse* — We create multiple designs each representing different DKK types in the taxonomy. This supports *Goal 2: Personal* and enables a technology probe to delve into the value of different aspects of DKKs (e.g., output modalities).
5. *Easy to study* — We focus on DKKs that do not require excessive implementation complexity or invasive privacy permissions in the context of a technology probe (e.g., contacts, webcam). This narrows down design options by filtering out DKK types like *Calendar Events/Reminders*.
6. *Desktop computer context* — We focus on the context of desktop computer (i.e., laptops and desktop computer screens). Compared to mobile phones, desktop computers are more often used for work-related tasks, which enables us to gain more insight into how playful DKKs are perceived in work contexts (supporting *Goal 1: Playful*). Focusing on a specific device form factor also helps facilitate *Goal 5: Easy to study*.

With these goals in mind, we created three different DKK design template prototypes. Each takes the form of a 256×256px floating window that can be zoomed and resized as desired to suit different screen arrangements and high-DPI screens. We intentionally went with simple designs to satisfy *Goals 1: Playful* and *2: Personal*, because open-ended designs can encourage playful interpretation and a wider range of customization possibilities, and *5: Easy to study*, because simple designs keep the study focused and reduce deployment complexity. Since the templates are also technology probes, simple designs were important, because technology probes “should be as simple as possible” and “open-ended” [37]. Their designs are as follows:

Virtual Pet (Figure 1a). A virtual pet in the form of an anthropomorphic alien-like character. The shapes and colours of body parts can be pre-configured. Clicking on the character triggers one of three predefined animations. This is based on the *Virtual Assistant/Pet* DKK type.

Picture Frame (Figure 1b). A digital picture frame that cycles through a fixed set of user-pre-selected photos every 30 minutes. The style, colour, and size of the frame and mat are pre-configurable. This is based on the *Meaningful Media Display* DKK type.

Sound Machine (Figure 1c). A continuous stream of one of six user-pre-selected ambient sounds, like crickets or rain falling. It is housed in window with a slowly animated visual of pre-configurable ambient scenes or abstract shapes, and the colour is also pre-configurable. The volume can be changed in real-time using a volume slider at the side of the window (the default volume is 0%). This is based on the *Soundscape* DKK type.

5 DIARY STUDY: EFFECTS OF DIGITAL KNICK-KNACKS

We used our DKK design templates as a form of technology probe [37] in a 10-day diary study. The goal of the study is to understand feelings towards DKKs and how they integrate into daily life.

The study took place in three phases: (1) a set-up session in which participants each designed their own variation of a DKK template; (2) participants lived with their DKK and wrote daily diary entries about their experience; and (3) a closing interview probed further into participants’ perspectives. The set-up and closing interview sessions were conducted in person or over videoconferencing software. The study was approved by our institution’s research ethics board.

While technology probes are often physical technological artifacts, we consider our DKK templates to be a technology probe because they share the same distinguishing features [37]: they are designed to be simple and open-ended, they are not intended to elicit usability feedback, they log data about their use, and they are designed to influence design rather than serve as iterative product prototypes. Similarly, this study is not intended to be a comparison of different types of DKKs. Instead, the different templates serve as an opportunity for participants to design a DKK that is more personally meaningful to them.

5.1 Participants

We aimed to recruit participants with a broad range of ages and occupations to obtain a range of unique perspectives. We sought participants who used their computer regularly for more than three hours per day, and who used a desktop web browser supporting unsigned web extensions (e.g., Chrome, Edge). We distributed the DKKs as web extensions because of their relative ease of deployment, ability for remote logging, and widespread platform support.

We recruited 10 participants (median age 30, IQR 11, 4 male, 6 female) via message boards and snowball sampling. Participants had a diverse range of occupations (e.g., engineer, nurse, physician, teacher, student, retiree). Regarding familiarity with desktop or portable devices: 3 participants described themselves as extremely familiar, 5 very, and 2 moderately. Regarding time spent using desktop or portable devices: 5 participants responded more than 8 hours per day, 3 for 6–7 hours, 1 for 4–5, and 1 for 2–3. We asked about participants' experience with specific examples of related forms of digital personalization: 4 participants used custom ringtones or notification sounds (1 of which used them regularly), all used custom wallpapers (6 regularly), 4 used animated screensavers (2 regularly), 9 used custom skins such as light/dark mode (7 regularly), 8 used home screen or desktop widgets (5 regularly), and 5 used custom icon or font themes. 2 participants selected the picture frame template, 1 selected the sound machine template, and the others selected the virtual pet template. Participants received an \$80 e-gift card as remuneration.

5.2 Phase 1: Digital Knick-Knack Design Set-up Session

We created a web app for configuring the different design options of each DKK template. The tool took the form of a wizard that first gave the choice of template, then contents (e.g., photos to put in the picture frame and sounds to put in the sound machine), then appearance options, including different visuals and tweaks to the visuals like size and colour.

In the initial set-up session, participants had the opportunity to explore the DKK tool and the different configuration options for their DKK. Once participants finalized their design, they would not be able to change it later during the diary portion of the study. We structured the study in this way to give participants a feeling of having a central role in the design. The session lasted approximately 10–30 minutes, depending on the participant.

At the end of the session, the design tool created a specification file that we embedded into a web extension representing the participant's DKK. We helped participants install the extension in their browser and verify that it was working. Participants were requested to keep the DKK open as much as they could for the remainder of the study, but they could interact with it as much or as little as they liked. The DKK remotely logged interaction events. The supplemental video demonstrates the DKK design process and usage.

5.3 Phase 2: Diary Study

Participants lived with their DKKs on their computers for 10 days, completing a daily diary entry. We set the study duration as 10 days to be long enough for novelty effects to wear off but short enough to not excessively encroach into participants' computer environments. This is similar to many past diary studies investigating novel software (e.g. [19, 68]), and participant comments indicate that they became used to and comfortable with their DKKs after only a few days of the study.

At the end of each day, participants were requested to complete a brief diary entry questionnaire with three questions: the valence and arousal scales of the Self-Assessment Manikin (SAM) [8], as

well as a short-answer question asking participants to reflect on their experience living with the DKK that day and write down their observations, thoughts, or opinions.

5.4 Phase 3: Closing Interview

At the end of the diary study phase, we conducted a semi-structured interview with each participant. We asked about participants' overall experience, whether they felt the DKK changed their experience of using the computer, why they designed it the way they did, and questions about aspects of the DKK, such as whether it matters who made it and whether they would like it on multiple devices. We also used the interview session to clarify points raised in diary entries. Each interview lasted approximately 25 minutes.

If a participant wished to keep using the DKK after the study period, we showed them how to disable the remote logging in the web extension.

5.5 Diary and Interview Data Analysis

For our qualitative analysis of the diary entries and interviews, we used a Template Analysis [41] style of thematic analysis to construct themes. Unlike Braun and Clarke's approach of *reflexive thematic analysis* [9], Template Analysis develops initial themes (the "template") earlier in the process, has a focus on iteratively developing and "trying out" the template during coding [11], and does not make as strong of a distinction between "codes" and "themes" [10].

The first author independently performed the analysis over several iterations. Before conducting the study, several concepts of interest had already been identified, specifically the notions of distraction, emotional value, and personal meaning. These were used as tentative initial codes in the template. The first author analyzed the diary entries before each respective interview, which allowed the interview to include more focused questions, but also led to the incorporation of additional concepts into the template, including the notion of using a DKK on multiple devices and the framing of the DKK design tool as a constraint. They then transcribed and coded the entire set of interviews (approximately 3.9 hours total) to construct inductive codes as well as extend and refine the earlier tentative codes. Our analysis recognizes knowledge as socially constructed, in that our experience as researchers and the context of our study shape the way we make meaning from the data. For example, the first author is familiar with theories and concepts related to games and play, which may have implicitly informed the analysis.

5.6 Results: Usage Log Analysis and Diary SAM Ratings

When the DKK was open, it was visible on average 25% of the time (SD 33%) for a given participant, indicating that participants did use their DKKs during the study, but there was large variability in usage across participants.

We calculated information about 'active sessions' with DKKs, in other words, periods of time that they logged interaction events (opening, clicking, hovering) within one hour of each other. On average, participants had 1.6 active sessions with their DKK each day (SD 1 session). The sessions were 33 minutes long on average (SD 60 minutes), but with a median duration of 6 minutes, indicating

that most interactions were short, but some participants engaged in prolonged interactions. On average, in each session, a participant would click on the DKK 7 times (SD 24 times) and hover 7 times (SD 18 times). Participants also described regularly looking at their DKK, even when they were not interacting with it.

By dividing the computer screen into 9 equal sections from “top-left” to “bottom-right”, we calculated the most common placements of the DKK on-screen, averaged across participants. Bottom-right, placing on a separate monitor (exact placement unknown due to browser API limitations), and top-left were the most common placements, followed by middle-right and top-right, which were considerably less common, followed by other placements. This indicates that screen corners were a generally favourable placement for DKKs.

For the SAM ratings in participants’ diary entries, there were no clear trends in valence or arousal over the course of the study. Overall, the average valence and arousal ratings were neutral (5 and 6, respectively, on a scale from 1–9), but with large variance across participants (SD of 2 and 2, respectively). This level of variability is unsurprising given that participants had varied perceptions towards the DKKs and participant diary entries frequently described changes in mood independent from the DKKs.

6 QUALITATIVE ANALYSIS OF DIARY ENTRIES AND INTERVIEWS

From the analysis of participant diary entries and interviews, we constructed five themes for perspectives on DKKs. These do not represent unanimous or universal opinions, but rather different perspectives that were prevalent among our participants.

6.1 Bringing joy and positivity

DKKs can bring joy and a positive mood to one’s day through several aspects. Participants appreciated the design of their DKKs; for example, the style of the picture frame (P4), the cuteness of the virtual pet (P3), the slowness of the visual changes (P1), and the incorporation of favourite colours (P2). The interactivity was also appreciated; for example, the ability to dynamically change between photos in the picture frame (P1) and to explore the different animations of the virtual pet (P6). DKKs were associated with positive memories or evoked feelings of nostalgia; for example, seeing photos from one’s hometown in the picture frame (P1), and reminiscing about past virtual pets like Neopets (P3) or Webkinz (P2). Avatar-based DKKs can bring an additional form of joy when considered as a form of companion. For example, P8 described hers as: *“I always feel happy whenever my digital buddy greets me every day. It’s like having a good friend who’s always there to brighten my mood”*.

Some participants felt that looking at and interacting with their DKKs supports their mental health (P8), and this was seen as a way of managing stress and anxiety. For example, P4 said the picture frame *“soothes me”* and *“keeps me calm”*, P2 felt that interacting with the virtual pet was a healthy way to *“manage the stress”* before an important meeting, and the sound machine helped P10 stay *“focused and calm”* when writing a document. The feeling of companionship from the virtual pet DKKs was also perceived to help with loneliness or provide cheer on a *“gloomy day”* (P1). For example, in a diary

entry, P3 wrote: *“I was particularly sad today. The digital knick knack made me cheer up a little bit. Just having silent company can be comforting.”*

Although the exemplar DKKs were not designed in support of social situations, they sometimes led to unexpected and joyful social interactions. For example, P2’s DKK was a *“conversation starter”* and an opportunity for *“showing off what I had made”*, and P3 engaged in a discussion with a friend about her DKK’s design. On computer screens in shared environments, DKKs can take on a life of their own in the broader space. For example, P8 had hers open on her home office computer, and family members would smile when they passed by and saw it. DKKs could also be designed to more intentionally encourage social interaction. For example, P7 suggested that he would be interested in a pair of *“corresponding knick-knacks”* that let one person send a *“wave”* to a friend with the other DKK.

6.2 Balancing the level of presence when working

DKKs can provide value in a work context, for example, by supporting taking breaks, but this is hampered if their on-screen presence is too strong or weak.

On one hand, DKKs were sometimes felt to be a distraction during work, perceived as *“in the way”* (P5) or *“annoying”* (P1) if they covered work-related windows. To see content underneath, participants needed to move the DKK to a different part of the screen, resize it smaller, or resize other application windows to not be underneath. Screen space also can come at a premium, especially on small devices. For example, P1 would use her small laptop in bed, limiting the availability of screen space. Some participants used multi-monitor setups and moved their DKK to a non-primary monitor to make more effective use of space.

Another consideration is that although the exemplar DKKs were not designed to demand attention, subtle changes, such as when the picture frame changed pictures or the virtual pet blinked, were something new that participants needed to adjust to. P8 described the process as: *“[The] first two, three days is just you always get distracted because [...] I have, like, colourful stuff over there, which blinks. So peripheral vision always sees it. But then you get used to it, right?”* Some participants specifically felt a sensitivity towards changing sounds or visuals, and chose a DKK template accordingly. For example, P1 avoided the sound machine template because of sensitivity to sounds.

On the other hand, because the exemplar DKKs were not designed to demand attention, when participants were busy with tasks, their DKKs were sometimes left aside, forgotten, or lost behind other windows. For example, a DKK could be *“completely ignored”* (P10) if another window was maximized on top of it. This neglect prevented it from being able to provide joy or help calm.

Several participants held the attitude that a computer is a *“tool”* (P5), in that playful or entertaining things do not belong in this context. For example, P5 explained that he used to use a typewriter, implying he feels the computer is its spiritual successor. Although some participants disliked the non-utilitarian nature of the DKKs, these participants felt more accepting of more utilitarian forms, and provided suggestions. For example, P10 wanted a DKK to provide

reminders to grocery shop and communicate any discounts. Some participants who used their computer for both work and leisure activities felt they would be more inclined to engage with their DKK when they are not working. For example, P1 wished hers could be displayed according to a schedule based on “*on and off hours*”. More broadly, there was a desire to moderate encounters with or control the “*amount of presence*” (P3) of one’s DKK.

A related attitude is that of being a digital “*minimalist*” (e.g., P4), in that anything perceived as not providing functionality, such as “*visual clutter*” (P7), is superfluous and should be removed. Similarly, there is an impression that extra content may consume excessive electricity or computer memory. However, some participants preferred having a more “*fun*” computer environment. For example, P1 said, “*I like when [widgets that are very productivity focused] also have things that are a bit more fun and casual, like pictures in them*”.

6.3 Being within “eye’s reach”

Interactions with DKKs were usually brief, and could be used as a form of break while working or when switching tasks. P2 described this as: “*So there was a couple tasks this week that I really didn’t want to do [...] but I would intersperse it with playing with it and making it jump around, just making it a little bit more of a positive endeavour in that task*.” Some participants related or compared the interactivity of their DKK to their physical knick-knacks. For example, P3 related her virtual pet to the figurines she keeps on her desk, contemplating how with the figurines, “*you can kind of like wrap your fingers around and do more motions with your fingers that way*”, and clicking on a DKK also has a “*tactileness*” that is “*satisfying in a unique way*”. P4 described the interactivity of the picture frame DKK as advantageous over a physical picture frame. Several participants also related their DKKs to a “*fidget toy*”, for example P7:

“I’ve always been a little bit like a doodler or fiddler. [...] And I found that on this phone call, I was sitting around waiting on hold, being transferred between departments, and just kind of having it up, looking at it, tapping on it, it gave me something to kind of distract myself from what was going on.”

Participants appreciated that DKKs were right on their screen, in that they were “*always within my eye’s reach*” (P3) and could provide value at opportune times without needing to switch contexts. For example, P3 said:

“I know that there was moments when I was a little upset during the time I was using my computer. And I didn’t really even have the mental capacity to think about having to look elsewhere. Just having it on my screen was incredibly convenient. And it did manage to kind of elevate my mood without me having to put much effort into it, which I appreciated.”

This highlights a perceived level of effort needed to switch focus away from the task at hand on the computer screen, which enabled DKKs to substitute for less desirable distractions, such as “*doom-scrolling*” (P2), “*scrolling TikTok*”, or “*watch[ing] a YouTube video*” (P6), because the DKK is the more convenient option. Some participants also highlighted that because DKKs are on-screen, they could

fiddle with something during a remote meeting without taking their eyes off the screen to still appear “*engaged*” (P7).

Another effect of having DKKs on-screen was that over time, some participants felt that their DKK came to be associated with the particular screen it was on. For example, P8 described her DKK as “*like a soul of this computer*” and that she would not want the same one anywhere else, and P6 described his as: “*it’s like it becomes your ‘work buddy’ as opposed to like just ‘take everywhere buddy’*”. This desire to have the DKK in a dedicated place helped participants feel more in control over moderating the amount of time they were spending with it. P3 described this using cat behaviour as an analogy:

“I feel like I’m more of a cat person, for example. Cats, they’re not always by your side all the time. They’re kind of wandering and only sometimes do you see them. I feel the same way about the knick-knack where I’m only occasionally seeing it when I’m on my computer, but I’m not seeing it in every single moment of every device I use.”

6.4 Forming a personal and contextual connection

Overall, participants felt that having put effort into the design of their DKKs gave them a stronger personal connection. P8 described this process as: “*if you cook something, it tastes better*”. When participants designed their DKKs, the process enabled them to incorporate their own memories. For example, P1 included a photo of “*me and my mom that always made me happy*”, and P3 designed her virtual pet to resemble a character from a video game she played as a child, engendering a feeling of nostalgia.

Personally designing a DKK also supports a feeling of ownership and control over it; in other words, a sense of pride because “*I designed this*” (P7), and satisfaction from deciding on a design that one “*really liked*” (P8). Having a say over the design also supports individual aesthetic preferences. P3 reflected on this in reference to a friend’s negative reaction towards her DKK’s appearance:

“I mean, based on, I think, my friend’s very visceral reaction, I imagine if I had given her this one that I designed, she wouldn’t have enjoyed it as much. And I think I would probably be the same way. I’m sure that her tastes would be very different to mine. And I think that that would affect my enjoyment of the knick-knack in the same way that when you choose a physical knick-knack, I think how it looks is very important. And you usually pick the one that visually looks the nicest to you. So being able to design it and make it the way you would like it to look, I think is very important.”

Some specific examples of personal aesthetic decisions included P9’s desire to incorporate her favourite colours and P10’s desire to choose sounds that she associates with comfort rather than nervousness.

Another important aesthetic consideration for participants was how well the DKK fits into the surrounding computer desktop context. For example, P1 would have preferred if her DKK had rounded corners because “*everything else*” has rounded corners,

and P9 felt that having a window border on hers made it stick out in an unappealing way.

When participants reflected on their experience using the DKK designer tool, some felt that “*you really did not [do] much to [the digital knick-knack], to make it yours*” (P6), and that the amount of effort they put into designing their DKK counted as less than “*design*” and was more akin to “*customizing*” (P9). Yet, while some participants would have preferred additional control over design options (e.g., P3 would have liked if the virtual pet could be rendered in a “*different art style*”), others appreciated the lower level of control because it required less perceived effort or technical ability. For example, P6 felt that if he were to make a DKK from scratch, his artistic abilities would limit its quality and personal value:

“I mean, to me, the ability that [...] you didn’t have to draw anything or come up with any type of idea was a positive. Because if you were to ask me to go design my own thing [...] I don’t think I would have come out with anything that I would [...] interact with nearly as much, just because it’d be like, too ridiculous and too silly.”

In other words, it may be challenging for some individuals to devise a valuable design from scratch, but there is still a strong desire to have a say in what it is like, and a perception that this level of control would still facilitate forming a personal connection with the DKK.

6.5 Retaining personal value over the long term

Participants appreciated the novelty of their DKKs after installing them, because they were something “*new and exciting*” (P2) and it was interesting to “*explore [their] features*” (P8). However, the DKKs became less exciting over time, because one “*will know what to expect*” (P8). For example, P1 started becoming tired of the photos in her picture frame DKK, and she regretted not adding more. Some participants found new uses for their DKKs, which provided emergent functionality. For example, P1 used hers to cover on-screen advertisements.

For longer-term use, participants felt it could be valuable for DKKs to support a greater variety of interactions to keep them interesting. For example, P6 suggested incorporating more Easter egg-like “*hidden actions*”, because he was interested by “*the idea that it did things without you knowing [everything] it did*”. Similarly, P7 suggested that a DKK could be more appealing if it provides a “*reason to look at and engage with*” each day; for example, if “*it gives you a little factoid of the day like, ‘blue whales weigh 18 tons’*”. These two examples show how a DKK could be designed to foster curiosity about what it will show or do. Some participants also felt it would be valuable for DKKs to have a way to change appearance based on mood or season. For example, P8 said:

“I like to change things according to the season. During the winter time, I probably want it to look like a snowball or something like that. Because, you know, I think everyone wants to change things up a bit.”

Even if DKKs were considered less exciting over time, some participants felt they became closer to, or more positive about them over time. For example, in a later diary entry, P4 wrote that his DKK is “*a part of my daily routine now*”. Similarly, P6 formed a tendency to refer to his virtual pet DKK by nicknames like “*Mr.*

Fuzzy”, and attribute a “*personality*” towards it. In this view, one can come to “*grow to enjoy*” (P3) a DKK without feeling a need to change its appearance.

7 DISCUSSION AND IMPLICATIONS

Based on our DKK taxonomy and analysis, we reflect on DKKs that are self-made, connect to past work and suggest implications for DKKs on other device form factors and social DKKs, and discuss the value of non-utilitarian DKKs.

7.1 Reflecting on the Self-made Nature of Digital Knick-Knacks

Supporting varying levels of control over design. Our *Forming a personal and contextual connection* theme addresses how people desire different levels of control over the design of a DKK. For example, P6 felt that having a starting point for design was useful in creating something personally valuable, whereas P3 felt that more control over the artistic style of the DKK would be desirable. This relates to Campbell’s distinction between “*customization*” (like P6) and “*craft consumption*” (like P3) [14]. This indicates that although a DKK is considered more personally valuable when the user has a say in its design, it may not be critical to have a highly-involved design process. DKK creation tools could borrow ideas from creativity support tools and computer-assisted content generation (e.g., text-to-image generation [43]) to facilitate a greater depth of design exploration for less design-oriented users.

Digital knick-knack design as a continual process. Blom and Monk [7] found that people continually personalize their computers and phones over time to “*accommodate their current emotional states*”. In contrast, our study restricted design changes to the set-up session, with no personalization options later. DKKs could also be designed to support continual modification by or interaction with the user.

For modification, a DKK could be decorated in anticipation for events, different moods, or seasons (e.g., P8) to make it feel new and relevant to the present. Taking this a step further, DKKs could be designed to support a continual process of creating through a craft-based process. This is similar to how bullet journals are an artifact that supports continual crafting, which can provide the creator with joy [74].

For interaction, a DKK could provide content that changes regularly, such as trivia (e.g., P7’s suggestion for a “*factoid of the day*”) or secret functionality (e.g., P6’s “*hidden actions*”), which would stimulate surprise and curiosity, and motivate maintained interest over the long term. Such DKKs could incorporate generative design or content, for example, similar to the “*memories*” features in popular social media and photo management applications. However, there is a tension between being personally meaningful and adapting with new generative content. Our analysis shows that DKKs were felt to be more valuable by being self-made. Participants highlighted that even personalized content can feel “*imposed*” (P6) if not intentionally displayed by the user, similar to how “*memories*” features can be insensitive about what content is brought up, and display content at inopportune times [39]. There is also a risk of excessive changes damaging the perception that a DKK is something personal. It could be valuable for DKKs to incorporate strong aspects of user

design, while allowing for continued surprises based on curated sets of content. For example, they could artfully combine photos and quotes selected by the user into a combined view, similar to a photo collage idea discussed in the brainstorming session.

Normalizing craft and making. More broadly, DKKs as self-made artifacts could serve to challenge the role of automation encroaching in our lives, such as automatic music playlists, news feeds, and photo “memories”. Bunz [12] argues that modern interfaces are “engendering stupidity as the desirable state [users] should be in”, highlighting how this leads to a tension between empowerment and patronization. It is important we design interfaces to empower users to create, rather than propagate the idea people should be passive content consumers. In line with this, Gauntlett [28, pp. 85–87] argues for the value of creating digital things that “conve[y] the powerful, inclusive, happy message that ‘anyone can do this’” and maintain a “human connection [...] with the work”. He proposes a vision for the future in which people “embrace a more social and connected life of creative exchange” [28, p. 237]. We see self-made DKKs as supporting a digital culture that places stronger value on craft and making, similar to how websites like Neocities² aim at reviving and normalizing the concept of unique, personal, and often playful webpages.

7.2 Digital Knick-Knacks Beyond the Desktop

Mobile form factors. Although our DKK taxonomy accounted for multiple device form factors (e.g., desktop computer, mobile phone), we focused on a desktop computer context in the diary study, which applies to both work and leisure contexts. Even with this focus, smartphone-related considerations were raised by participants. On one hand, it may be preferable to display non-utilitarian DKKs in leisure contexts associated with smartphone use (e.g., P1), but on the other hand, phones have reduced screen space, meaning that DKKs could more easily get in the way of other content (e.g., P7). Another consideration is that smartphones and other smart devices like smartwatches are designed to facilitate brief glances and interactions. If DKKs occupy this transient digital space, it may move them from being ‘on display’ closer to being “placeless” [62] like conventional digital possessions that are stored away.

Because smartphones are associated with leisure activities such as browsing social media, there are also unique concerns around smartphone dependency. For example, P6 said, “it’s easy to switch from one thing to another”, referring to how easy it is to be distracted by other content on a smartphone. In line with our *Being within “eye’s reach”* theme, situating a DKK in the same context as an ongoing activity could help avoid context switches. This is also supported by habit-forming psychology, which proposes increasing the accessibility of healthier alternatives as an effective way to avoid interference from bad habits [83].

Spatial digital knick-knacks. Aside from conventional screen-based contexts, DKKs could extend to contexts like XR (extended reality). In XR, they could occupy physical space and take on more properties of physical knick-knacks (e.g., sculptures), while still leveraging advantages of the digital (e.g., self-made artwork created in a 3D painting application). Haptics could be used to support novel

²<https://neocities.org/>

tangible interactions with such DKKs, supporting an enjoyable “tactile experience” (P3) like that of fidget widgets [40]. Alternatively, 2D DKKs like our templates could be placed as interactive ‘stickers’ or posters on flat surfaces in the environment like walls and tables. They could also integrate more seamlessly into environmental surfaces by adopting ideas from ambient displays (e.g., projections of content on surfaces [38]) and interactive architecture (e.g., shape-changing displays [57]).

7.3 Social Considerations for Digital Knick-Knacks

Agent-like digital knick-knacks. Although the focus of our exemplar DKKs was not social, DKKs could be designed to have social function by creating agent-like *Virtual Assistant/Pet* DKKs that communicate with the user in some way. Conventional interfaces like Clippy, or hybrid digital objects, like anthropomorphic smart home assistants or smart speakers (e.g., Sense Mother sensor hub [70], LG Hub robot [47]) could serve as inspiration. However, such agents conventionally tend to have fixed personalities and appearances with limited customization options [85]. To provide more personal relevance, agent-like DKKs would need to break from this homogeneity by satisfying personal aesthetic “tastes” (P3). A possible advantage of agent-like DKKs is that they could provide personal support beyond the mental health considerations raised by participants (e.g., P8). Given that chatbots can have meaningful impacts on users’ emotions, such as easing feelings of anger [16], DKKs that integrate such functionalities could provide stronger emotional value or foster a feeling of nurturing.

Self-presentation in shared spaces. If displayed in public contexts, DKKs also have implications for self-expression and self-presentation. Our templates primarily focused on being meaningful to an individual, rather than something shown to other people. However, technology is often put on display in public situations; for example, on shared computer screens in a home, or on a smartwatch worn in public. In these contexts, DKK design needs to expand to consider whether it reflects how one wants to express oneself. For example, to support a “minimalist” self-image like that of P4, DKKs could provide simple or elegant design options. As another example, DKKs could take inspiration from smartwatch faces, which people set according to their desired self-presentation or to match a given outfit [33].

Self-presentation also extends to shared digital environments; for example, how avatars on online communication platforms serve as a form of personal expression. Avatar DKKs (a subset of our *Self-representation* type) could incorporate social status within a platform. For example, our brainstorming session identified that DKKs could change appearance to represent achievements or show the quality of contributions to an online platform. In digital virtual spaces or sandboxes like Mozilla Hubs³ or Roblox⁴, avatars and props can be displayed within a more immersive virtual environment, leading to additional considerations similar to those for XR.

³<https://hubs.mozilla.com/>

⁴<https://www.roblox.com/>

Facilitating social behaviours. Digital-knicks could also provide value by facilitating social behaviours, such as establishing a remote connection between family members. For example, a participant in the brainstorming session described how a DKK could display a real-time feed of a child’s drawing. Similarly, P7’s suggestion for a pair of “*corresponding knick-knacks*” could be achieved in a similar way to Sengers et al.’s “Virtual Intimate Object” [69], in which the colour of one’s DKK changes based on a someone else’s interaction.

7.4 Digital Knick-Knacks for Play and Work

Works that discuss certain historical playful features (e.g. [71]) have dismissed them as unsuccessful in work contexts, and participants such as P8 initially thought that DKKs would provide limited value beyond “*just entertainment*”, before changing their minds. Our analysis shows it is possible to design non-utilitarian DKKs that provide value today.

Balancing attention demands and level of presence. Historical DKKs were sometimes designed in ways that demanded attention and disregarded the importance of having a balanced level of presence. For example, Clippy would pop up at inconvenient times [84], and the Neko mouse cursor extension [15] would cover other content. Virtual pets incorporated game-like design elements that required continuous attention, such as feeding and cleaning. It is important for non-utilitarian DKKs to maintain a balanced level of presence. If too hidden, they can be forgotten (e.g., P10), which limits their ability to provide value, whereas if too present, they can get in the way and become distracting (e.g., P5). Presence could be reduced by appealingly fitting into the surrounding context (e.g., P1). DKK designs also need to offer a choice of output modalities to avoid becoming overbearing. For example, designs that produce sounds may interfere with already-playing music (e.g., P3). Similarly, sudden visual or auditory changes, even if small or infrequent, can grab attention and be distracting (e.g., P2 near the beginning of the study, in reference to the virtual pet blinking). When the user is not interacting, smooth, slow transitions between states are preferable. Nevertheless, there may be value in intentionally designing DKKs to evoke nostalgia associated with historical designs. For example, software Easter eggs sometimes incorporate design elements from historical software, such as how one theme in recent versions of Microsoft Office includes a rendering of Clippy in the background [45].

Incorporating playful design. Recent work by Altarriba et al. [1] highlighted how play can provide joy, support people’s agency, and facilitate social connection. They give examples of how play can “re-signify” serious contexts such as office environments, and they borrow Gaver and colleagues’ notion of ludic design [30], in that designing for ambiguity and flexibility of interpretation can elicit curiosity and exploration. In line with this, designing DKKs to be intentionally ambiguous [29] could support emergent functionality and improve long-term engagement. For example, because our DKK templates were dynamically resizable, P1 repurposed hers to cover advertisements. Similarly, a participant in our brainstorming session described how a *Help/suggestion System* DKK that shows computer coding best practices could be displayed on top of less relevant information in the user interface. More broadly, based on

our taxonomy, non-utilitarian DKKs could provide value to users through a number of playful ways, such as aesthetics (e.g., being soothing or funny to look at or listen to), interactivity (e.g., acting as a fidget toy, piquing curiosity), triggering memories or nostalgia (e.g., embedding personal media), or acting as a companion (e.g., anthropomorphic design). While not everyone will receive all DKK designs positively, there is a potential for personally-relevant designs to provide value across a wide range of people.

7.5 Limitations and Future Work

We conducted this research in a North American cultural context. It would be valuable to investigate perceptions of DKKs in other cultural contexts. For example, how should they be designed for households in which devices are shared by multiple people, and how do cultures that have different norms surrounding technology use perceive DKKs?

As mentioned earlier, our diary study focused on a desktop context. Mobile devices have a number of differences, such as generally being less associated with work and more frequently used when travelling, and having different patterns of interaction, smaller screen areas, and generally shorter product lifespans. Future work could further investigate DKKs in the context of mobile devices to understand the effects of and design opportunities afforded by these differences.

Although our exemplar DKK designs included options for audio, our understanding of DKKs is primarily as a visual-first type of digital possession. It would be valuable to understand how DKKs can be designed by and for people with sensory disabilities and how they can better leverage different output modalities; for example, in the vein of work investigating the visual art experiences of blind people [48].

Most participants in the diary study selected the virtual pet template. The primary reasons for this were that many of our participants already used their desktop background to display personal photos, listened to music when using their computer, or had a sensitivity to sounds. Because of the smaller-scale size of our diary study (10 participants) and this weighting towards the virtual pet template, we learned more about the value of the pet template than the others. However, the goal of our work is to investigate the general concept of DKKs and how people feel about living with them, and the primary purpose of having the different templates was to provide the most opportunity for participants to design a DKK that was personally meaningful. Future work could conduct larger-scale studies, including focusing on particular contexts (e.g., only in office environments), or investigating nuances of specific types of DKKs, especially utilitarian designs and designs that deal with more personally-relevant data (e.g., contact information).

8 CONCLUSION

We defined a class of digital possessions called *digital knick-knacks* (DKKs), which are audiovisual digital possessions or embellishments. Unlike conventional digital possessions, which are often stored away, duplicated, and shared across multiple devices, DKKs are digitally ‘on display’, analogous to how physical possessions are put on display in physical spaces.

We developed a taxonomy for designing DKKs, and we used it in a brainstorm with HCI researchers to generate example DKK designs for us to categorize into different types. We created three exemplar DKK design templates based on three of the types. We deployed them as a technology probe in a 10-day diary study in a desktop computer context, in which participants designed their own variants of the template designs. Based on a qualitative analysis of the results, we learned that DKKs are capable of bringing joy. They can be distracting in work contexts, but they can also take the place of more undesirable distractions such as scrolling social media feeds. Incorporating users into the design enables DKKs to support a stronger feeling of personal connection. DKKs are something that one can grow more fond of over time, but they are also susceptible to novelty effects. From our analysis, we also proposed implications for design, such as how DKKs can be made more suitable for work contexts.

We hope this work inspires thinking about digital environments as more than utilitarian tools, and leads to more explorations of the capabilities computers have for supporting humans emotionally and socially.

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A BRAINSTORMING SESSION DIGITAL KNICK-KNACK TYPES AND EXAMPLES

Table 3 provides a summary of participant examples generated in the brainstorming session, corresponding to the different digital knick-knack types and theoretical works described in the taxonomy.

Table 3: Summary of participant examples from the brainstorming session.

Theoretical Work	Dimension	Examples
Csikszentmihalyi & Rochberg-Halton, Richins	Memories	meaningful media display (e.g., photos from one year ago)
	Associations	calendar events/reminders (e.g., list of upcoming religious holidays)
	Experience	help/suggestion system (e.g., recipe suggestions), note-taking (e.g., scratchpad for personal goals)
	Intrinsic qualities of object	N/A
	Style/appearance	self-representation (e.g., virtual fashion item representing self)
	Utilitarian	note-taking (e.g., digital movie journal)
	Personal values/identity	self-representation (e.g., virtual trophy)
	Interpersonal ties	informatic (e.g., heartbeat monitor of friend, visualization of most frequent contacts)
	Financial aspects	informatic (e.g., visualization of subscription costs, daily expenditures), playful notification (e.g., sound effects upon financial transactions)
Csikszentmihalyi & Rochberg-Halton	Personal	informatic (e.g., step counters, representation of facts about others in remote meeting)
	Social	informatic (e.g., public display of one's exercise amounts; displays of carbon dioxide emissions, stock prices), automation (e.g., tool for splitting prices)
	Cosmic	informatic (e.g., display of constellations), meaningful media display (e.g., display of nature images)
	Differentiation	informatic (e.g., visualization comparing friends' screen time), automation (e.g., grammar checking tool that accounts for personal style)
	Integration	informatic (e.g., visualize time spent with friend), automation (e.g., quick shortcuts to call contacts)
Richins	Instrumental	N/A
	Symbolic	N/A
	Ordinary	N/A
	Prestige	help/suggestion system (e.g., discount finding tool), self-representation (e.g., badges)
	Necessities	automation (e.g., button to automatically order food), informatic (e.g., visualization of how often commands are used in an application)
	Recreational	self-representation (e.g., badges for gameplay), help/suggestion system (e.g., suggesting outdoor activities), embedded game (e.g., minigame activated as Easter egg)
Oulasvirta & Blom	Stabilization	informatic (e.g., visualization of most recently used commands)
	Interest	note-taking (e.g., place to collect snippets from the web)
	Exploration	playful notification (e.g., sound effect when finding a new application feature), help/suggestion system (e.g., suggesting rarely-used commands)
	Differentiation	help/suggestion system (e.g., tool for comparing commands in applications), automation (e.g., tool for creating further automations)
	Emotional expression	soundscape (e.g., system that plays background music based on mood), informatic (e.g., stress level visualization)
	Ego-involvement	informatic (e.g., visualization of how frequently contacts typically respond)
	Territory marking	calendar events/reminders (e.g., a public calendar highlights how one is feeling each day)
McCracken	Exchange rituals	calendar events/reminders (e.g., list of items that need to be returned to others), meaningful media display (e.g., digital postcards), informatic (e.g., visualization of what application commands friends frequently use)
	Possession rituals	self-representation (e.g., badges), automation (e.g., button to delete unused apps), informatic (e.g., visualization of how often commands are used in an application)
	Grooming rituals	help/suggestion system (e.g., tool to suggest outfits based on weather and current trends)
	Divestment rituals	playful notification (e.g., brief visual indicators of file actions), note-taking (e.g., digital whiteboard with 'clear all' function)
Tian & Belk	Prosthetic possessions	N/A
	Atmospheric texture	help/suggestion system (e.g., guide that shows coding rules and best practices), soundscape (e.g., system playing ambient coffee shop sounds), automation (e.g., tool for blocking notifications)
	Identification with corporate self	N/A
	Sense of past and sense of future	meaningful media display (e.g., showing motivational quote)

Theoretical Work	Dimension	Examples
	Possessions for play	playful notification (e.g., animated flying bird animation when sending emails), automation (e.g., tool to monitor dog and automatically dispense food), embedded game (e.g., minigame activated by accomplishing important tasks), virtual assistant/pet (e.g., virtual pet)
	Work self and home self	meaningful media display (e.g., real-time display of child's drawings), automation (e.g., tool to monitor home)
Belk	Dematerialization	N/A
	Reembodiment	meaningful media display (e.g., digital yearbook photos), informatic (e.g., visualization of fitness achievements), note-taking (e.g., place to list out New Year's resolutions)
	Sharing	informatic (e.g., visualization of time spent using software)
	Co-construction of self	self-representation (e.g., avatar with representation based on online communication quality), virtual assistant/pet (e.g., virtual friend that provides encouragement)
	Distributed memory	automation (e.g., tool to ask others online how to do something), meaningful media display (e.g., collage combining personal and friend's photos)