

Investigating the Presence, Form and Behavior of Virtual Possessions in the Context of a Teen Bedroom

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ABSTRACT

Over the past several years, people have acquired more and more *virtual possessions*. While virtual possessions have become ubiquitous, little work exists to inform designers on how these growing collections should be displayed and how they should behave. We generated four design concepts that changed the form and behavior of these digital things, making them more present within a teen bedroom. We then conducted speed dating sessions [9] to investigate how these new forms and behaviors influence perceptions of value. Sessions revealed how new technologies might better support self-exploration and reflection, as well as how they could complicate identity construction processes. Findings are interpreted to detail opportunities and tensions that can guide future research and practice in this emerging space.

Author Keywords

Teenagers; Virtual Possessions; User Enactments; Speed Dating; Design Methods; Bedroom; Home

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Most teens feel the greatest sense of place attachment to their bedroom [6]. Here they live with their things, make sense of their lives, and work to understand the complex changes and challenges of growing up [25]. The bedroom provides moments for solitude and reflection, a social space to engage parents and peers, and a canvas to experiment with an evolving sense of self [17]. Teens display and curate their precious material possessions in their bedrooms in order to explore their changing values and aspirations, and project them to different audiences. Through this process, they construct value with their things; mentally reassigning an individualized sense of worth as they possess and repeatedly use their things over time [3]. The bedroom provides teens with their first opportunity to author a space, to create their own aesthetic and sense of style in negotiation with their parents [25].

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Figure 1. The messy teen bedroom prototyped in our lab.

Digital devices and services have become an increasingly large part of teen life [18] and teens commonly alternate their attention and interactions between their material and *virtual possessions*. Virtual possessions include things that are increasingly immaterial (e.g., books, music, and photos) and things that never had a lasting material form (e.g., game avatars, electronic message archives, social networking profiles, and metadata traces logged during interactions with various systems). Our previous fieldwork with teens investigating value construction with material and virtual possessions in their rooms, and how these materials shaped teens' identity construction processes revealed that they work to make virtual things more present, and that they draw on them as critical resources for self-reflection and self-presentation to different social groups [22].

The study reported here focuses new forms and behaviors of virtual possessions that support curation and presentation of self to different audiences. Specifically, we wanted to understand how on how making virtual possessions more present in the bedroom and giving them new forms and behaviors influence teens' perceived value of these things. To do this, we generated four design concepts: an auto-redecorating bedroom, postcards sent from a teen's past, electronic gift giving, and a system for curation of multiple selves. We then constructed a bedroom in our lab and conducted speed dating sessions [9] with 14 teens. This provided a prism for investigating aspects of several potential futures that teens may or may not desire.

Speed dating sessions revealed that teens desire (i) to have their virtual possessions more present as long as they can control this presence, (ii) to curate multiple presentations of self while retaining a sense of authenticity, and (iii) new

forms and behaviors that better support reflection on past self and on the relationship they have with another. These findings suggest significant opportunities for the HCI community to create new forms and behaviors for virtual things in order to modify people's perceived value of them, particularly in terms of *ability to investigate one-on-one relationships* and *supporting reflection on the past*. They also reveal an opportunity to develop richer forms of metadata, and the infrastructure required for its capture, storage, retrieval, and sensitive treatment.

Our research makes two contributions. First, it advances the HCI community's understanding of how teenagers construct value with their virtual things, alluding to future product and service forms. Second, it provides a case demonstrating how speed dating with user enactments can work to investigate potential futures.

BACKGROUND AND RELATED WORK

Technology use in and around the home

The ways in which technology affects the social and moral order of the home, and how it might be better designed to improve domestic life continue to be major areas of concern in HCI. Edwards and Grinter [11] discuss how even relatively simple technologies can disrupt domestic routines and practices. Subsequent work has emphasized developing technologies that make people feel more in control of their lives, rather than focusing on control of devices and services [8]. Building on the issue of control, Woodruff et al. [29] illustrated how ceding control to a smart home can help families focus on building social relationships. More generally, Vetere et al. [28] describe the complex ways technologies mediate intimate relationships and the need to make new designs more rich, nuanced and expressive.

Teenagers and their domestic places have received less attention in HCI. March and Fleuriot [21] explored how technology mediates teens' need for private space within their parents' home. Durrant et al. [10] proposed ways that teenagers' curation of digital photos opens up opportunities for intergenerational interaction and identity construction. Hodkinson and Lincoln [17] suggest teens increasingly use social media technologies to extend boundaries beyond the bedroom. Additional work has investigated how teens work to maintain offline relationships through interactive technology [e.g., 26]. More generally, teens are seen as defining new social mores through their use and appropriation of social computing technologies [e.g., 4].

Our work picks up these threads, advancing HCI's understanding of how teens control and might better control their bedroom. Our user enactments investigate digital photos and social networks, and how digital possessions and social computing services might change the way teens desire to express themselves and construct value with their possessions, both digitally and materially.

Privacy and self-disclosure

As everyday technologies have become networked, a wealth of literature has emerged concerning privacy and unwanted disclosure. Palen and Dourish [23] unpack the

multi-dimensional nature of privacy practices, drawing attention to how they are not limited to tensions between people, but also involve a person's internal conflicts over how disclosure shapes their self-concept. Many important works too numerous to mention here have since built on this seminal article, working to reduce unwanted disclosure across mobile platforms and networked services (see [1] for an in depth review). Outside of HCI, Goffman's [15] sociological work reveals a range of performative practices people engage in to manage self impression and disclosure to different social audiences. Giddens [14] later argues that the act of managing presentations of self across different settings can lead to an integrated, holistic life narrative.

Additionally, there is growing interest in how to support designers in considering user values (such as privacy) throughout the design process [e.g., 12]. Much of this work helps illustrate how designing technologies reflective of users' values can productively open the space for people to construct a deeper sense of value or 'worth' with these things [see 7]. Our user enactments investigate both the context and forms for new technology for both self-reflection and self-presentation. Our designs are intended to probe, in order to better reveal the issues and tensions around privacy, disclosure, self-presentation, and self concept.

Digital content, archives and collections

Recently, researchers have begun to explore the implications surrounding the virtualization of material artifacts, such as photos [27] and familial possessions [20]. Approaches to designing digital objects characterized by immaterial qualities are continuing to emerge in parallel [16]. New research also describes how people develop attachment to digital artifacts. Kirk and others [20] present a values-oriented approach to designing tools to support archiving of cherished digital artifacts. Kaye et al. [19] describe how digital archives can function as rich resources for identity construction and presentation. Van House [27] details how digital photos presented online can support curation of identity to different groups. Our research draws on these themes to inspire our designs for the bedroom.

OUR PRIOR RESEARCH

Previously we conducted ethnographic interviews with 21 teens in their bedrooms to investigate their perceived value of virtual and material possessions, and how these materials shaped teens' identity construction practices [22]. Our findings detailed design opportunities for value construction activities with immaterial things. These include:

Value in presence—Teens worked to make their virtual possessions more present. This included: constantly changing backgrounds on personal devices; printing status updates and comments from friends to display in their rooms; and maintaining a persistent, online connection in order to monitor the virtual world.

Value in self-reflection—Teens used their virtual possessions to reflect on their past. This included investigating how many times they listened to a song;

storing printed status updates; and reflecting on popular culture and other images featured on their computer previously. They used both system logs and human constructed metadata to understand who they have been.

Value in curation of multiple selves—Teens used virtual possessions to ‘curate’ different selves to different audiences. Actions included applying interface ‘skins’ on gaming consoles; encoding photos of a shared experience into the metadata of songs in playlists given as gifts; and tagging/untagging of photos as well as restricting/granting access to photos and other social media content.

TEEN BEDROOM SPEED DATING STUDY

The goal of this study was to advance our understanding of how the design of virtual possessions that were intended support identity construction activities might influence perception of value and meaning. We chose to conduct speed dating sessions with “user enactments” (UE) [9] to help better understand our target audience as well as potential opportunities and risks in the design space. In real-life speed dating, people have dating props such as a wine glass, café table and candle. They go on many very short dates in a single evening, and at the end, they know very little about any of the people they met. However, they have developed a much better and more realistic vision of what they want in a partner. Speed dating with user enactments follows the same approach. Design teams create rich scenes of possible futures. They then bring in representative participants who find themselves in a familiar scene and then experience a “sip” of what the future might be like. Prior to each enactment, participants are asked to reflect on their current practices and desires for the future. At the conclusion, they are asked to reflect on how the enactment may have complicated or supported these desires, or led to unexpected experiences. By combining wide exploration across multiple structured engagements, user enactments provide a broad perspective to find new design opportunities and to reveal potential underlying social tensions around new technology.

Our process followed three steps. First, we synthesized the strands of related research and findings from our field study through repeated discussion and affinity diagramming. Second, we operationalized our insights in the form of applications for engaging with virtual possessions. Third, we conducted speed dating sessions with teens to reveal design opportunities and implications.

We began with in-depth review sessions of our field data, related research and design opportunity areas. During these sessions we made affinity diagrams and free form diagrams to gain a perspective on the situation. We then held several concept generation sessions, resulting in 94 concepts. We clustered these thematically to understand the overall design space and to more clearly articulate visions of preferred and undesirable futures. We iteratively filtered these clusters based on their fit to: design opportunities, the importance of the issue probed by the concept, and the

feasibility of realizing the concept through a user enactment. We then more fully realized twelve remaining concepts by making detailed scenarios and through body storming [5]. Again, we filtered these concepts resulting in the final set we developed into user enactments.

Our enactments required a teenager’s bedroom, which we constructed in our lab (Figure 1). Our design process for this began with printing photos of teen rooms we collected in our previous study and placing them on the wall. Using them as a resource, we then constructed a bedroom space, continually tweaking and augmenting it until it “felt” like the rooms we had visited. A major addition to the room included twelve overlapping displays that fill the wall above the teen’s desk. These were made from black and white foam-core, and we used a high definition projector to create the illusion that they functioned as independent screens. We intentionally created a set of displays that could be easily integrated into the bedroom, while at the same time might be perceived as overwhelming. We hoped this tension might provoke teens to critically reflect on the amplified presence of technology in their personal space.

Similar to Schön’s notion of design as a reflective conversation with materials [24], we engaged in a reflective dialogue with the narrative and the problem framing each design raised. Through repeated meetings to critique scenarios, we iteratively refined the user enactments, often increasing the fidelity by using props and acting out scenes in order to develop a consistent narrative flow. We then repeatedly piloted the enactments. Piloting helped refine our design of the physical bedroom. It also revealed unanticipated narrative problems, which we addressed by developing a specific order for enactments. Finally, piloting helped to find the harmony between giving participants too much freedom and making the scenario mostly exposition.

We crafted the scenarios around a fixed set of digital content provided by two teenagers (male and female, respectively). We chose to do this for two reasons. First, participants have different sets of virtual possessions (e.g., some have large music collections, while some listen to music online; some archive text messages, while others are less meticulous; etc.). Reliance on participants’ personal collections would have removed an important control: making sure participants reactions were based on the same stimuli. Additionally, it would make the enactments only as rich as the collections teens keep *now*. Second, acquiring teens’ personal collections and building personalized versions of the room would have significantly increased our efforts. One of the key challenges with designing new technology is to reduce the risk of development for things people do not ultimately desire. Our intention was to ground our intuitions and avoid making an over commitment to a specific design direction. We needed to do UE to help reduce the risk associated with taking a conceptual leap to an emerging design space that has few existing conventions to draw on.

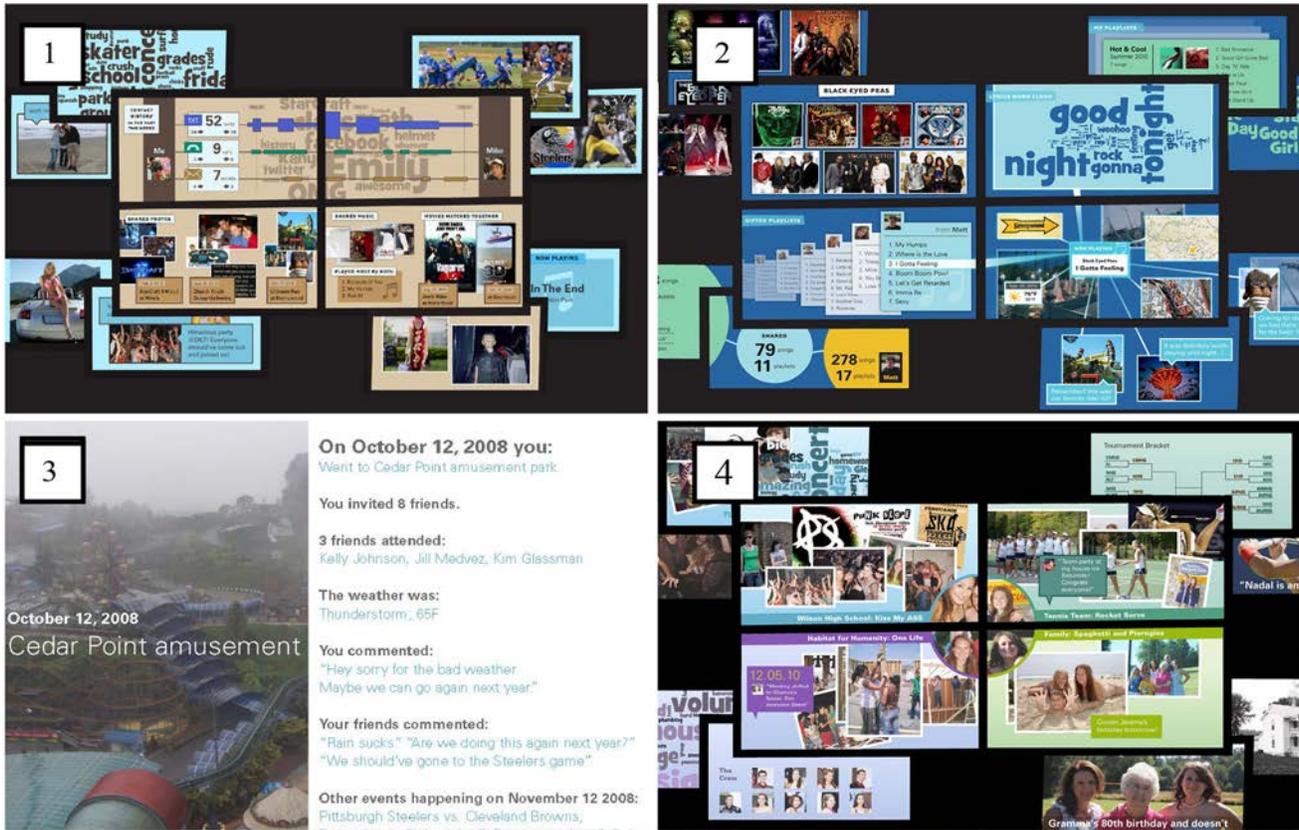


Figure 2. (1) UE1: after redecoration, displaying communication pattern with friend as well as shared interests. (2) UE2: displaying gifted playlists and personally inscribed data. (3) UE3: Postcard from the past composed of metadata scraped from social networking pages. (4) UE4: four views of self: (clockwise from top-left) School, Sports team, Family, Church.

User Enactments for Speed Dating

UE 1: Redecorating Bedroom—The participant enters the bedroom after dinner in order to read an Act from *Romeo & Juliet* to prepare for an upcoming exam. 12-displays show various collections, including: a visualization of messages exchanged with friends over the last two weeks, favorite music, photos of a wild party with comments, provocative pop-culture images, and personal photos related to sports and family. A confederate (of the same gender) plays the participant's friend. They show up and enter the room, triggering five of the screens to automatically re-decorate; presenting new information of shared activities and interests between the two friends. The screens highlight events both attended, images from parties, a visualization of communication patterns, and images of the two friends in Halloween costumes from a time before they knew each other (see figure 2.1). The confederate alludes to the meaning and function of the displays through a semi-structured conversation. After a few minutes of discussion, another confederate in the role of a parent knocks. The participant presses a remote to change the displays to “parent approved,” masking the provocative image and party photos. The participant then allows the parent to enter and drop off folded laundry.

This enactment explored issues surrounding the control of virtual possession displays against the backdrop of different social audiences entering and exiting the room. It

investigated questions including: Do teens value a system that automatically presents digital content relevant to particular people in the room? Will virtual possessions from a teen's past (i.e. Halloween photos) conflict with their current perception of self?

UE 2: Gift Giving—The participant is sitting in the room listening to music, while waiting for a friend. The song she/he is listening to is from a playlist given as a gift to them by their girl/boyfriend. 12-displays present machine and human-produced metadata for the current song as well as a collection of annotated photographs assembled by the girl/boyfriend from visit to an amusement park together. Metadata for the photos lists the time, day, and weather information as well as a topographical map. Other screens display a set of gifted playlists, information about listening habits between girl/boyfriend and participant, and wordclouds of lyrics (see figure 2.2). After spending a few minutes in the room, a confederate friend arrives, notices the screens, and engages the participant in a semi-structured conversation alluding to the meaning and function of the displayed information.

This enactment aimed to investigate questions including: Is a digital gift perceived to be more valuable if it reveals more of the effort someone put into making it? To what extent could social or machine-logged metadata help

support the work of crafting a digital thing expressive of a social relationship between two people?

UE 3: Postcards from past—The participant sits in the bedroom when a parent confederate arrives with two postcards mailed to her/him. The postcards present information and metadata scraped from a teen’s social networking account from two years ago. One summarizes personal stats, including the number of: friends on Facebook, people they most frequently tagged in photos, untaggings of self in photos, etc. The other (see figure 2.3) shows an amusement park trip shared with friends, including both social information (e.g. friends that attended, comments about the event) as well as other metadata (e.g. weather and temperature, other events happening that day, celebrities visiting the park that year). After a few minutes, the parent confederate returns to say dinner is ready.

The enactment explored questions including: Would receiving a physical postcard constructed from old metadata be perceived to support or conflict with self-reflection? How far is ‘too far’ for teens to look into their past? Does revealing that the system keeps digital traces of activity make teens feel uneasy?

UE 4: Curating Multiple Selves—Sitting in their bedroom after school, the participant views four different versions of their social networking profile targeted at four different audiences: family, school friends, sports team, and church (see figure 2.4). These are linked to incoming and outgoing digital communication. They enable the teen to post status updates, comments and other content to each group individually. After a few moments she/he receives a text message from a member of the sports team, and this quadrant highlights. She/he reads the text message (on a phone provided to them). A few moments later a different quadrant indicates another text message has arrived from a school friend. The corresponding quadrant highlights and she/he reads that message. The enactment concludes when a parent confederate knocks and asks her/him to get ready for sports practice.

This enactment investigated questions including: Will teens perceive the ability to explicitly manage different presentations of self to different groups valuable? Are teens disturbed by the explicit fragmentations of their social groups, and the presence of this information in their room?

Participants and Data Analysis

We recruited 14 teenagers ranging in age from 14-17; eight female and six male. Teens were recruited through flyers posted in several different areas of Pittsburgh and through word of mouth. Throughout the paper we refer to each participant with a sex specific pseudonym followed by her or his age (e.g., Sally-15). The design of screens for Enactments 1, 2 and 4, which emphasize personal content, were adapted to feature sex specific names for both the participant’s character and their friends.

Before beginning the enactments, researchers gave participants a bedroom tour, introducing “their” digital and

physical belongings. Researchers primed participants for each enactment by offering brief explanations of interfaces and then describing an activity to start with. Participants were also asked to reflect on their own everyday behaviors and experiences. This provided researchers with additional insights, and primed participants for drawing connections between their own lives and the possible future presented in each enactment.

During the enactments we played popular contemporary music popular in the background to deemphasize that this was taking place in a lab. Following each enactment we conducted semi-structured interviews, asking participants to reflect on their experience. We began by asking about their everyday practices, and then transitioned to talking about the specific enactment. This technique appeared to help participants fluidly make connections between the daily experience and the potential futures. Sessions lasted between 75 and 90 minutes.

We video recorded the speed dating sessions, which resulted in nearly 18.5 hours of video. We also took notes during sessions. The research team then met weekly over the course of four months to repeatedly review the video and notes in order to draw out underlying themes. Textual documents were coded using these themes. We also created conceptual models and affinity diagrams to reveal connections across participants and across enactments.

FINDINGS

During pre-enactment interviews, teens commonly described themselves as technology users and reported using computers and mobile phones everyday. All teens had personal bedrooms. Upon first entering our bedroom, many noted similarities between it and their own room in terms of objects and messiness. In the following sections, we present several examples taken from speed dating sessions that capture four primary emerging themes: the desire for presence and imperative of control; desire for curation of multiple selves and tensions surrounding authenticity; desire for self reflection by looking back; and desire to investigate relationships through evidence of action.

Presence and control

Almost every participant had a strong, positive reaction to how the 12-displays made their virtual possessions much more present within the bedroom. They valued that the displays could both support representing their self to others and investigating who they are right now. In terms of the increased presence, teens stressed the importance of controlling the display, both in terms of turning it on and off, and in terms of managing the content. Sara-15: “...I like that it’s bigger in the room. ...more available to me. I can lie around on my bed ...look at it, think about how to connect with people, but then it needs to go away. If I can’t ...it’s going to make me paranoid or obsessed.” Similar to Sara, several teens described how the constant presence of their virtual things might lead to obsessive behaviors.

Participants related the practice of displaying objects in their rooms to the 12-displays. Anna-15: “It’s all the things

that are out [on display] that make up a big part of who I am. ...This [motions to the 12-displays], you can see those connections between your different things. ...Those connections can kind of show who you are in a way. ...It's not really different from physical things, but there's no way to do that today." Anna's statement captures what many teens said, how seeing relationships and connections among their things could make them more valuable.

Several teens described how elements of UE1-Redecoration and UE4-Multi-self could help support self-development and discovery. They seemed very much aware of the work they were doing in their bedrooms to understand themselves. Derek-16: *"I'm figuring out who I am and coming into my self as a person. This could be really useful for thinking about who I am and who I might be comfortable being."*

The enactments showed that the desire for control involved both turning displays on and off as well as curation of what was displayed. Sara-16: *"there are photos on Facebook of me and my friends that I want to have up in my room but I can't. [parents will not allow] ...They are an important part of me and my life ...that [my parents] aren't part of. ...I'd want to have [photos of friends] up, like posters on the wall, ...Like live with them. ...But a big part of living with them is also living my life outside of them. ... I have to have some real space away from them."*

The display of specific content from electronic messages also emerged as highly contentious and in some cases inappropriate. Sam-16: *"having the actual messages of like texts or Facebook displayed up there, I think I would panic. Even if I could control it, what if someone walked in the room? ...[They're] way too personal, who knows what someone's going to send you and who'd see it."*

Interestingly, UE1-Redecoration's screens presented wordclouds of text message archives (either the cumulative sent by self or those exchanged with friend). This provoked some teens to speculate on potential workarounds offered by this alternative form: *"I write so many texts to so many people I lose track of what I've said. ...Those [wordclouds] feel like they'd give me time to pause and think about the meaning of what's sent. ...It feels like a special thing that I'd have with someone else. ...Other people could see it, but we'd be the one's that'd know what it means."* (Mary-16).

Authenticity and Multiple Selves

UE1-Redecoration and UE4-Multi-self explored how teens would react when confronted with technologies that explicitly displayed presentations of self to different social groups. During our iterative piloting of UE-4, we used university students as stand-ins for teens. These college students often reacted negatively to the idea of displaying different representations of self to different social groups. Our teen participants, however, had an entirely different reaction: *"I need them to be separate because I can't express everything I want to if everyone is listening. ...I don't want to seem fake, I mean I'm real to everyone, but in ways that make sense in each situation. This [application]*

would be really helpful" (Mary-16). Mary's reflection captures how teens were typically comfortable with having multiple digital presentations of self clearly segmented and manageable.

The automatic and manually-triggered redecorations of the room to present content tailored to a person or social group in UE1-Redecoration did raise concerns. Redecorating was perceived to evoke contrived, inauthentic presentations. Mary-16: *"...the screens show a lot about my relationship with a friend in a different kind of way than the physical things leftover from [shared] experiences with them. But I would rather look at it on my own to think about what we've done together. ...Having [the screens] change when she comes in feels strange. ...It seems like I'm stalking her. ...If she's coming [over] ...I want to focus on being there with my friend."* Several other teens described how the redecorating screens could cause peers or parents to perceive they are hiding aspects of their lives from them, potentially leading to awkward and undesirable situations.

Self reflection by looking back

Several enactments triggered reflections on how records of their interactions with digital materials could surface as resources for looking back on who they were at different times in their life. In what follows, we detail how teens drew on the applications to envision how they could be used for reflecting on the past. We then highlight how teens unexpectedly linked the perceived value of these things with less frequent interactions with them over time.

The enactments provoked teens to consider how technical systems keep traces of their interactions as metadata and how access to this data could shape their perceptions of virtual possessions. We suspected the personal-behavior postcard (in UE3), which presented machine-captured metadata summarizing a teen's behavior from two years ago, would cause conflicts by prying 'too far back' into the past to their 'pre-teen' days. Surprisingly, this was often not the case and most teens desired to, as Mary-16 stated, *"go back more into the past ...to when I can't even remember"*. Some participants described how the postcards could stimulate co-exploration of the past with friends or family: *"I don't know what was happening when I was younger and I like the idea of the [postcards] going back a few years each time I get them until they were back to when I was a baby. ...I've wondered about what was happening then, but I don't bring it up with my parents much. ...[postcards] would provide a little bit of information to start a conversation"* (Eric-16).

Teens also described how mundane records of their online activities might support a new way of recalling past experiences: *"Who I'm tagging [in photos] now, shows who I'm around. [My] friends are a big part of who I am. ...Knowing that information when I'm older feels like it would make me think a lot about what I was doing then and who I was"* (Tim-16). In some cases, teens envisioned the postcards would accrue value over longer periods of time: *"...how many times I untagged myself from a photo or who*

was tagging me and when and where. ...In five years, ten years, twenty years, that could be a really special way of thinking about what was happening in my life then” (Stephanie-17). However, several teens expressed that a lack of transparency in when and how this data was captured over time, and where it was stored, as well as the potential to be reminded of fights with parents and friends could complicate the perceived value of these things.

During interviews following UE1-Redecoration, several teens described how materials taken from bedroom walls were rarely captured. In some cases, they expressed a desire to ‘save’ the state of their virtual possession displays to revisit them. Anna-15 uses a bedroom wallpaper metaphor: “Everything in my room and on my walls is a reflection of me. ...I put new things up and take other things down ...here [in this application] there are pictures of friends, bands everyone liked, different pictures of you and what you’re into. ...They could keep layering on top of each other like wallpaper. ...You could peel back the layers and see what’s underneath. ...it would be making a saved record [of my life] from what I do over time.”

Other teens described how revisiting the spatial layout of virtual possessions decorating the room could stimulate a different experiences of remembering: “...when I’m older it would be cool to bring up all of my digital things and how they were arranged in my room during different years. ...it feels different than thinking about an experience that’s in a photo. ...It’s not about remembering an experience I had, more like what it felt like to be in my room when looking up at how I arranged everything” (Marisa-17). When probed further on how frequently she would use this kind of application, Marisa stated: “I’d probably come back to it every four or five years. Like after I finish college or I’ve gotten married. ...what I’d treasure is going back [to it] when my life is changing and immersing myself in who I was and think about where I’m going.”

Marisa’s comment captures how several teens speculated the value of these things as resources may in part be tied to the rate at which they are encountered. Interestingly, the potential value of infrequency became one of the largest unexpected themes, emerging across several participants and enactments. This theme emerged in some cases in relation to the multiple selves application (in enactment 4). Eric-16 describes saving different ‘states’ of his different social groups to revisit in the future: “...the meaning won’t come from seeing them everyday. ...It’s like the photo albums of me when I was a child. I look at them every other year. ...This [application] would be like that. You could save what you’re doing ...and have it as a special way of thinking about who you were by who was around you.”

Understanding relationships through evidence of action

The majority of digital content represented across all UEs usually centered on some form of evidence of action. This included forms constructed to explicitly reinforce a social relationship, such as the gifted playlist in UE2. It also included many implicit forms symbolic of shared practices

or exchanges, such as the graphical breakdowns illustrating the number of times tagged in a photo with a friend (UE3); or the times a song has been listened to collectively among friends (UE2). In what follows, we describe how teens drew on these forms to envision how they could support reflection on valued social relationships.

In UE1-Redecoration, the communication summary screen becoming present as the friend enters provides an implicit evidence of action; it illustrates the frequency of SMS messages, emails and phone calls exchanged between two friends. This screen in particular provoked several discussions. Katie-17 describes how these records could construct a social portrait only readable to friends in the relationship: “It makes me think of a landmark to remember people by. I can look at it and see when we were interacting and think about what we were doing. ...It’s something that only her eyes would understand.” Marisa-17 envisions how the low resolution of this implicit form might stimulate more active recollections of relationships compared to photos: “...in a photo album there are lots of memories and in this there are lots of memories too. ...The way I think I would use them to remember is different. Like with a photo album, I look at it, I see each photo and, like that, I remember what was happening then because I’m seeing it. ...With the [communication visualization] only I know what went on when all those messages were sent and so I have to think back, and put it all together myself...”

Many teens described holding onto the physical cases and discs from mix-CDs given to them by friends even though they accessed the music on digital music players. Some teens reflected on the less expressive qualities of other digital gifts: “...for me, one of the most important things about getting a card that someone made is having it around during that momentary time that’s special in my life. ... [and] think about what went into it. ...With e-cards there’s nothing personal about them, nothing real went into it so they don’t feel like they represent much” (Eric-16).

However, reactions to the gifted song playing in UE2-Gift tended to contrast Eric’s sentiment. Tim-16 describes the explicit evidence of work conveyed by the application: “It’s using the digital medium in ways that are hard to do with the physical. ...What I mean is a person can put together these photos and tag them with comments and put other information ...the point is all of this comes together to make an experience that’s different than listening to music someone gave you sometime. ...I see it like a handwritten letter. ...when I read it, it’s like that person is coming through the paper because they went through the trouble to write and had an intention. ...[the digital gift] feels like the [girlfriend] put some effort into making it say something.” Tim’s statement captures what several teens remarked on, how different kinds of metadata could be used to explicitly convey the work that went into crafting a unique digital thing symbolic of a valued relationship.

DISCUSSION AND IMPLICATIONS

Our findings produced a range of insights on how the presence, form and behavior of virtual possessions shape teens' sense of identity and how they might help them better curate different aspects of self. In what follows, we first discuss how speed dating sessions challenged findings from our prior study and produced some unexpected results, specifically in terms of: increasing presence, balancing authenticity and multiple selves, and looking back on the past and exploring personal relationships.

Increasing Presence

We previously observed teens working to display virtual possessions in their bedrooms and to breakdown boundaries between the material and virtual world. However, from this fieldwork, it was unclear if teens desired systems that significantly amplify the presence of their digital collections. We expected teens to find the 12-screen display to be invasive, overwhelming, or even inhibiting. However, nearly all had positive reactions, valuing how it could provide a better understanding of their things and support their work to understand themselves and their relationships. These perceptions were clearly contingent on teens having control over the presence (and absence) of their virtual things but not the presences of the displays.

There is an opportunity to rethink the bedroom in terms of digital displays as well as how new interaction methods might lead to better situated control over screens' contents. In addition, there is an opportunity to better leverage screens currently found in bedrooms (mobile phone, computer, television), helping them to work together as a more integrated and artful display system. Further, virtual things can be made present in many ways, and screens are only one option. There is also an opportunity for creating physical forms (e.g., the postcards in UE3), light based forms or even auditory forms, which could support familiar ways of manipulating the presence and absence of things.

Authenticity and multiple selves

Our prior fieldwork described how teens drew on their virtual possessions to curate different presentations of self to others. Our user enactments made this "fragmentation" of a teen's self more explicit through UE1's auto-redcoration and UE4's curation of four different selves. We wanted to investigate if future technologies should acknowledge or even reinforce the fragmentation, or if they should work to make teens feel more whole.

Redecoration particularly seemed like a good idea, as it is less explicit than UE4's four selves and it builds on the inherent strength of virtual possessions to instantaneously appear and disappear; something physical possessions cannot do. However, teens perceived the socially reactive display in UE1 as potentially inauthentic and attention seeking. Teens instead desired to be with friends or family when in their presence, and then to use virtual possessions to reflect on these relationships later when alone.

The multiple selves screen in UE4 raised issues over unwanted self-disclosure. Teens appeared quite comfortable

when faced with seeing their self as multiple, curated selves. They felt the fragmentation could somehow make their lives seem more manageable. In some cases, they envisioned how saved records of these fragmentations could provide resources for reflecting on personal growth across life transitions and stages.

One explanation of this could be that teens have more segmented lives than other people. They move between their home and bedroom, partially controlled by their parents, and their high school, controlled by both peers and school rules. As they work to construct a self identity, they have the experience of being at least two people much more than young adults who create a separate life when they leave their parents' home and begin to control their own space. In keeping with Giddens [14], this surface-level fragmentation can be crucial to teens' work to construct a unified life narrative and, in essence, develop a concrete sense of self. Nonetheless, these issues are indicative of how the teen world is different from other populations, and what is expressed here must be viewed carefully before being applied to other groups of people. It does however raise some interesting general issues for investigating how people living together, such as couples, form and learn to share space, and share physical and virtual possessions that are representative of the couple or collective group.

Exploring the past and personal relationships

Our prior fieldwork revealed that teens used virtual possessions to reflect on their near past self. They often did not possess many virtual things that dated more than a few years into their past. UE1's presentation of Halloween photos depicting the teen at a young age as well as discussions following UE3's postcards both aimed to provoke teens to confront their earlier in their lives. We anticipated teens would find they complicated their current self-image; however, this often was not the case. Many teens desired to go deeper into their past, and they perceived collections of metadata operationalized by the postcards to be valuable for looking back on their practices. At the same time, their reflections indicated the value associated with the cards may come from occasional interaction, rather than constant presence.

Several UEs used forms that summarized personal relationships by revealing evidence of action. We displayed visualizations of communications sent and received (UE1), wordclouds of text messages indicating the frequency of word usage (UE1), favorite shared media (UE1), interfaces for making digital gifts more present (UE2), and experiences like trips shared together (UE3). While most social networking visualization tools currently offer a view of a person's complete network, these unintentionally provided windows into individual relationships. Teens reacted positively to these concepts, often describing how they could become aesthetically integrated into bedroom practices and provide mechanisms for actively expressing the social bond shared with another person. They clearly desired ways to see the evidence of the actions taken by themselves and others as a way of understanding who they

are with that person and possibly where they want to go with that person.

Design Opportunities and Considerations

Collectively, these findings suggest many opportunities for the design of new technologies that increase the perceived value of teens' ever growing collections of digital things. Our findings highlight the importance of both human and machine-produced metadata. Systems that elicit human produced metadata and devices and systems that generate their own metadata have not been designed to support reflection on past self or reflection on the relationship with another. Going further, this indicates an opportunity for richer forms of metadata that can better support these desires. The opportunities include infrastructure for capture, storage, and retrieval; devices that keep and share metadata; and interactive tools that support display and reflection. Here, we detail two opportunity areas to advance the form and behavior of virtual possessions and open up new ways for teens to draw on them as resources in the bedroom.

Ability to investigate one-on-one relationships—A common factor shaping teens' perceived value of virtual possessions centered on how they could provide resources for investigating a one-on-one relationship with a friend. These findings generally match prior research on teens' ritual exchanges of text messages to express and affirm close relationships [26]. However, the digital materials used in these social processes are becoming more diverse, and questions surrounding how they could enrich social relationships are complex. Socially reactive virtual possessions becoming present when friends and family entered the room was clearly disruptive. Teens wanted to develop relationships with specific people when they were around, and to use technologies to explore, reflect on and "live with" these relationships when alone.

There is an opportunity to develop systems that capture metadata related to shared activities. In particular, teens described how being "tagged" together with friends on social networking sites enabled them to explore experiences with particular people over time. This kind of data could summarize how shared actions between two people have evolved over time. This opportunity highlights how everyday interactions with digital technology create layers of metadata, which could provide unique resources for viewing, exploring and expressing social relationships.

There is also an opportunity to use virtual possessions to represent actions between two people. The visualizations of SMS and email exchanges between friends in UE1 provoked several reflections from teens on how they could provide a new kind of "landmark to remember people." These low-resolution exchanges triggered speculations on how this communication could support active recollection of shared experiences. This also led to the visualizations being perceived as publicly presentable within the room, while remaining privately 'readable' only to those in the relationship. In a sense, systems can capture actions that are evidence of friendship, which help build and sustain a

specific relationship. These materials can help create aesthetic forms of digitally mediated social exchanges open to being actively drawn on, or simply persist in the background. This direction could build on the history of work in HCI at the intersection of ambiguity in design [13] and slow technology [16] to explore how as these visual and interactive forms could be integrated into and slowly emerge as facets of bedroom culture and space over time.

Supporting reflection on the past through new materials—Teens' reflections across enactments showed how virtual possessions could provide resources for reflecting on their past. Several teens desired to 'save' versions of displays. Anna drew on the metaphor of wallpaper to describe how she would use saved states of her bedroom to "peel back the layers" and experience a sense of place from the past. There seems to be an opportunity to create applications that record the history of people's virtual possessions and enable them to view how they changed in the future. For example, an application could save versions of desktop images on past computers. As virtual possessions grow in number, more opportunities to create a history of their arrangement will also grow.

Teens also strongly perceived value in aggregations of metadata that capture information about their actions from the past (e.g., the postcards in UE3). It is currently unclear how to extract both human and machine-produced metadata from third party services. New systems can be developed to begin archiving digital records to create new resources for reflection. An example of this could be a background display that visually communicates thematic shifts in one's status updates, or simply the occurrence of momentous and mundane events over many years across life transitions.

Several teens also wanted to visit their virtual possessions several years into the future. This suggests opportunities for systems that anticipate making virtual possessions re-emerge in people's lives over longer periods of time. An example of this could be a system that actively archives summaries of events attended or photos posted online, and delivers them to their owners years into the future.

Practical and ethical issues for designers and developers—There are many ways to advance the form, presence and behavior of virtual possessions to investigate significant social relationships and reflection on one's sense of self. However, these opportunities also raise possible negative outcomes. When exploring these emerging design spaces it is important to consider how complications could emerge around metadata and evidence of action, as well as new risks of persistent digital records.

While metadata could enrich close friendships, it could also emphasize counting actions as opposed to the value of individual actions. Metadata captured by systems could become the currency by which relationships become defined; this may not always be the most relevant way to support social relationships. Additionally, as virtual possessions are increasingly created through and archived by third party services, they are given a lasting permanence

different than material possessions. This makes virtual things increasingly vulnerable to surfacing in unintended contexts, highlighting how complex being able to 'forget' them will be. Future systems should support this need and, indeed the act of forgetting can itself be considered an opportunity [2]. These issues are crucial when critically considering the role of future technology in positively supporting the forming and sustaining of social relationships, moving toward a concrete concept of self, and reflecting back on the past. These should be considered as the HCI community moves forward in developing systems that support value construction activities with virtual things.

CONCLUSION

We conducted user enactments with teenagers to investigate the role of future technologies in the bedroom could play in supporting (or complicating) identity construction processes. With this paper, we hope to develop insights about how new systems could be created to help people construct more value with their virtual things. Speed dating UE provided a way of moving beyond studies of teens' current practices. It allowed us to engage teens in confronting possible benefits and tensions as they drew on their own experiences to make sense of possible futures. Findings highlighted several new opportunities for increasing the presence and advancing the form and behavior of virtual possessions, and key tensions related to their development. We are currently developing technology probes based on these findings.

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REFERENCES

- Ackerman, M., Mainwaring, S. 2005. Privacy issues and human-computer interaction. Garfinkel, S., Cranor, L. (eds.) *Security and Usability*, 381-400, O'Reilly.
- Bannon, L. 2006. Forgetting as a feature, not a bug: the duality of memory and implications for ubiquitous computing. *CoDesign*, Vol. 2, 1, 3-15.
- Belk, R. 1988. Possessions and the Extended Self. *Journal of Consumer Research*, 15, 2, 139-168.
- boyd, danah. 2007. Why Youth (Heart) Social Network Sites: The Role of Networked Publics in Teenage Social Life. *Youth, Identity, and Digital Media Volume*, 1-26.
- Buchenau, M. and Suri, J. F. Experience Prototyping. In *Proc. of of of DIS*, (2000) ACM Press, 424-433.
- Chawla, L. 1992. Childhood Place Attachments. In Altman, I. (ed.). *Place Attachment*. Plenum, 63-86.
- Cockton, G. 2006. Designing worth is worth designing. *Proc. of NordiCHI '06*, 165-174.
- Davidoff, S., Lee, M., Yui, C., Zimmerman, J., Dey, A. 2006. Principles of smart home control. *Proc of UbiComp '06*, 19-34.
- Davidoff, S., Lee, M., Dey, A., Zimmerman, J. 2007. Rapidly exploring application design through speed dating. *UbiComp '07*, 429-446.
- Durrant, A., Frohlich, D., Sellen, A., Lyons, E. 2009. Home curation versus teenage photography: photo displays in the family home. *Int. J. Hum.-Comput. Stud.* 67(12): 1005-1023.
- Edwards, K., Grinter, R. 2001. At Home with Ubiquitous Computing: Seven Challenges. *UbiComp '01*, 256-272.
- Friedman, B. 2006. Value sensitive design. *Interactions*, 3, 6, 16-23. ACM Press.
- Gaver, W. Beaver, J., Benford, S. 2003. Ambiguity as a resource in design. *Proc. of CHI '03*, 233-240.
- Giddens, A. 1991. *Modernity and Self-Identity: Self and Society in the Late Modern Age*, Stanford University Press, 187-201.
- Goffman, E. 1959. *The Presentation of Self in Everyday Life*. New York: Double Day.
- Hallnas, L., Redstrom, J. 2001. Slow Technology: Designing for Reflection. *Personal Ubiquit. Comput.* 5, 3, 201-212.
- Hodkinson, P., Lincoln, S. 2008. Online Journals as Virtual Bedrooms? Young People, Identity, and Personal Space. *YOUNG* 16, 1, 27-46.
- Ito, M. et al. 2010. *Hanging Out: Kids Living and Learning with New Media*. MIT Press.
- Kaye, J. et al. 2006. To have and to hold: exploring the personal archive. *Proc. of CHI '06*, 275-284.
- Kirk, D., Izadi, S., Sellen, A., et al. 2010. Opening up the family archive. *Proc. of CSCW '10*, 261-270.
- March, W., Fleuriot, C. 2006. Girls, technology and privacy: "is my mother listening?" *Proc. of CHI '06*.
- Odom, W. Zimmerman, J., Forlizzi, J. 2011. Teenagers and Their Virtual Possessions: Design Opportunities and Issues. *Proc. of CHI '11*, 1491-1500.
- Palen, L., Dourish, P. 2003. Unpacking "Privacy" for a Networked World. *Proc. of CHI '03*, 129-136.
- Schön, D., Bennet, J. 1996. Reflective Conversation with Materials. *Bringing Design to Software*, 171-189.
- Steele, J., Brown, J. 1995. Adolescent room culture: Studying media in the context of everyday life. *Journal of Youth and Adolescence*, 24, 5, 551-576.
- Taylor, A., Harper, R. 2002. Age-old practices in the 'new world': a study of gift-giving between teenage mobile phone users. *Proc. of CHI '02*, 439-446.
- Van House, N. 2009. Collocated photo sharing, storytelling, and the performance of self. *Int. J. Hum.-Comput. Stud.* 67, 12, 1073-1086.
- Vetere, F. et al. 2005. Mediating intimacy: designing technologies to support strong-tie relationships. *Proc. of CHI '05*, 471-480.
- Woodruff, A, Augustin, S., Foucault, B. 2007. Sabbath day home automation: "it's like mixing technology and religion". *Proc. of CHI '07*, 527-536.