

Teenagers and their Virtual Possessions: Design Opportunities and Issues

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ABSTRACT

Over the past several years, people have increasingly acquired *virtual possessions*. We consider these things to include artifacts that are increasingly becoming immaterial (e.g. books, photos, music, movies) and things that have never traditionally had a lasting material form (e.g. SMS archives, social networking profiles, personal behavior logs). To date, little research exists about how people value and form attachments to virtual possessions. To investigate, we conducted a study with 21 teenagers exploring the perceived value of their virtual possessions, and the comparative similarities and differences with their material things. Findings are interpreted to detail design and research opportunities and issues in this emerging space.

Author Keywords

Virtual Possessions, Teenagers, Interactive Systems Design,

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Human Factors, Design.

INTRODUCTION

Many parents confess a strong attachment to books they read to their children at bedtime; often keeping and cherishing these books long after their children have left home. If e-readers replace physical books, will parents who read digital stories to their children instead develop an attachment to a particular device, or digital file?

We live in a world increasingly filled with *virtual possessions*. We characterize virtual possessions to include the many objects that are losing their lasting material form, such as books, music, photos, plane tickets, and money. In addition, we also consider them to include things that never traditionally had a material form, such as video game avatars; electronic messages including email, SMS, IM and status updates; social networking profiles; personal behavior logs, such as purchase histories; visited locations

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from services such as brightkite.com; and a listing of activities, such as jogging routes from MapMyRun.com. It appears that the convergence of social and cloud computing, along with the growing presence of mobile media players and networked mobile phones/computers has produced a world in which people both carry and ubiquitously access large collections of virtual possessions.

Research on material practices [e.g. 10, 23] and on material possession attachment theory [e.g. 6, 20] both describe the importance of material artifacts and the activities they support. Through the use of their things, people create meaning in their actions and construct an individualized sense of value for their things. The HCI community has learned the importance of understanding the practices and activities of users in the process of designing digital artifacts intended to augment more traditional material practices [e.g. 19, 27]. In many cases, HCI researchers and practitioners have focused on how the digital can improve performance in terms of efficiency and effectiveness. However, rarely has the HCI community investigated how the form and presentation of an immaterial thing might modify its value.

This research project takes a step towards better understanding the perceived value of virtual possessions. Specifically, we conducted a field study looking at practices of teenagers. This paper makes two contributions. First, it offers a designerly perspective of virtual possessions as a resource for people's value construction activities; a perspective that draws on the theories of material practices and material possession attachment. Second, it details three opportunity areas around value construction with immaterial things: value in accrual of social metadata; value in placelessness and presence; and value in curation and presentation of self to multiple audiences; along with these design opportunities, we note several key concerns to help critically frame future work in this emerging area.

BACKGROUND AND RELATED WORK

Related work falls into three areas: product attachment and material culture; teenager bedroom culture; and intersecting HCI research.

Studies on material possessions describe attachment as arising from meaning making that emerges as objects are integrated into one's life and help form idealized future goals [9]. Material culture researchers have explored how

possessions shape everyday practices and the construction of social values, relationships, and meaning [e.g. 23]. A strand of material culture research has been particularly concerned with how new value emerges as people personalize artifacts in everyday life [e.g. 10]. Here, material possessions provide a key resource that people use to make sense of the world, demarcate social relationships, and assign value to people, places, and things. This work illustrates how consumptive practice has a key moral component driven by utilitarian needs, personal values, and socio-cultural, economic and political structures [1].

A key strand of consumer behavior research investigates the ways in which people develop a deep love for their possessions. Meaningful attachment can emerge through the process of *self-extension*, where people attribute important aspects of their self to the persons, places, things and events symbolized by their possessions [6]. Consumption of material goods offers continuous opportunities to perform, affirm and manage the self [also see 14]. Through these interactions over time and in the presence of other social groups and environments, people develop a reflective sense of self and establish deeper attachments to their things [6, 20].

Research on attachment has also focused on the importance of the home as a place where people can manifest a presentation of self. Researchers have reported that teenagers often feel the strongest attachment to their bedrooms [8]. Here, teens surround themselves with precious possessions as they experiment with their identity through display of self to parents and peers [31]. Teens particularly tend to draw on displays of music, movies, celebrities, etc., as a way of authoring their space and communicating values [3].

With the emergence of the Internet, people have begun to create digital selves. Social networking sites enable people to create personal online places where they can design and reformulate experimental selves. In contrast to earlier work exploring identity experimentation among anonymous users in online environments [e.g. 33], recent studies have drawn attention to how performances of identity in social networking sites are unfolding in largely ‘anchored’ social relationships, where members of social groups are typically bound by offline relationships [2]. With these new modes of self-expression comes production of new kinds of virtual possessions, reflecting key elements of the past as well as future idealized goals [29]. While adults have large

collections of material and immaterial things, teenagers have emerged as rapid adopters of technology and are growing up in a time when their possessions are increasingly virtual [17, 32].

The HCI community has a rich tradition of investigating human relationships with material artifacts to productively inform the design of new interactive technologies [e.g. 18, 24, 27]. Recently, researchers have begun to explore implications surrounding the increasing virtualization of material artifacts, such as currency [21], music [4] and sentimental objects [19]. More generally, the issue of how to approach designing digital artifacts largely characterized by immaterial qualities has been an area of ongoing interest in HCI [e.g. 16].

There is also emerging HCI research describing how people develop sentimental attachments to digital artifacts. Kirk and others [19] present a values-oriented approach to designing tools to support archiving of cherished digital artifacts. Durrant et al. [11] explore how the curation of digital photos could open an expressive space for intergenerational interaction in the home. Others have explored how physical mementos can inform the design of systems aimed at creating digital mementos capable of triggering reflection on past experiences [e.g. 24, 27]. Finally, Peesapati et al. [26] designed and implemented a system re-presenting social networking content back to users specifically to evoke reminiscences.

Additionally, there is growing interest in exploring the ways in which designers consider the values of their users throughout the design process [e.g. 12, 18, 32]. Outside of HCI, the processes through which value and values are constructed on individual, cultural and societal levels have been a fundamental area of inquiry in the social sciences and humanities [e.g. 1, 10, 14].

Our work attempts to bring these different strands of research together within the purview of HCI. We want to investigate how people construct value with their immaterial things and provide designers and researchers with insights on how they might create technologies and systems that enable people to find new (or increased) value with their virtual possessions.

FIELD STUDY METHOD

We recruited 21 ‘tweens’ and teenagers from a mid-sized city in the United States, ranging in age from 12-17; 9 female and 12 male. We chose this group for three reasons:



Figure 1. Left to right: (a) John’s walls deeply reflected his current interests, (b) Michelle’s mobile phone served as a portal to online places, (c) Julia’s Jonas Brothers shrine now stored in the closet, (d) Bill extended digital copies of physical drawings to friends online.

they are deeply occupied with the process of constructing their identities [31]; they are heavily engaged in digital media, online communication, and use of interactive technologies [e.g. 17]; and they are on the vanguard of social and cloud computing, embracing these emerging technologies and actively defining the behavior and social mores of these products and services [e.g. 7, 32]. Participants hailed from middle and upper-middle class families, and typically had direct access to the Internet. It is important to note, our teenage participants clearly had less time to acquire massive archives of virtual possessions as compared with older populations, and we in no way mean to indicate that they are the “best” or only group to investigate. We see them as an important group and one that prior research indicated would likely be productive to study; as such, they are the first group we chose to focus on.

We conducted semi-structured interviews in participants’ bedrooms that lasted 1.5 to 2 hours. Interviews aimed to develop an understanding of participants’ everyday lives, common activities, technology-usage trends and cherished physical and virtual possessions. The bedroom elicited reflections about participants’ relationships with material possessions, provided a basis of comparison to their virtual possessions, and revealed how participants access, engage with and organize their virtual and material possessions. We asked participants to give us a tour of their material possessions both stored in and on display in their bedroom, and to describe their relationships with these artifacts. This was typically followed by a tour of participants’ virtual possessions, where we observed virtual artifacts on their personal computer, phone, media player, etc.

We videotaped all interviews and took field notes and documentary photographs. Following [29], the research team repeatedly reviewed field notes, video and photographs, and drew out underlying themes. Textual documents were coded using these themes. We also created conceptual models and affinity diagrams to reveal unexpected connections across participants. Very early findings of a pilot study were reported in [25]; in this paper we increased our participant pool and expand extensively on the collected field evidence and resulting design issues and opportunities. In what follows, we refer to each participant with a pseudonym followed by his or her age.

FINDINGS

Interviews and observations in teenagers’ bedrooms revealed a range of ‘precious’ material possessions. These included photographs of family and friends, artifacts such as collages created by friends, and mementos and symbols of personal achievement, such as academic and athletic awards. The display of these possessions matches findings from research on teenage bedroom culture [e.g. 3, 31].

Discussions revealed diverse collections of virtual possessions, including but not limited to several years worth of homework assignments, blog entries, status messages from social networking systems, archived SMS

messages, digital video, various self-made digital artworks, and expansive archives of digital music (often with accompanying artwork). Participants generally were frequent users of digital media, including music and video they owned and that they accessed through services such as youtube.com and hulu.com. Digital photos surfaced as a major category. Photos roughly broke down into images of family, friends and social events; photographs as art; and photographs specifically taken to document cherished material possessions such as items made by friends.

In many cases, our participants conveyed a general trend of moving away from shared home computers towards use of individually owned personal computers in their bedrooms: However, in some cases participants reported also using shared family computers from time to time. Additionally, all but one of our participants owned a mobile phone and/or media player, which emerged as common devices through which virtual possessions were accessed, made and managed.

In the following sections, we present several examples taken from field observations that capture the emerging themes: storage of virtual possessions; how virtual possessions are curated and displayed to manage presentation of self; how social metadata can be a crucial part of virtual possessions; and how artifacts transition between material and virtual forms.

Storage of virtual possessions: drive for accessibility

In general, interviews with participants indicated a strong trend away from storage on local computers to a reliance on and preference for cloud computing. Below, we describe instances in which mobile devices emerged as temporary storage centers; how movement towards the cloud shaped participants’ interactions; and how email was drawn on to more easily move possessions from place to place.

We observed participants kept many things on personal computers, mobile phones, digital cameras, and media players, and to a lesser extent on other forms of physical media. In addition, participants both expressed desires for their virtual possessions to be immediately accessible in and outside of the bedroom. Devices that restricted the transfer of virtual possessions often complicated this goal. As a coping mechanism, we found several participants conveyed a strong preference for storing their things on a range of cloud services. For example, Suzy-17 reflects on her 3-year old archive of photos, nearly all now stored online, “*I have to have [access to] them wherever I’m at ...on my bed or at the mall. ...I’ve been uploading all of [my photos] online. Obviously I can’t look at them all and that’s not the point. I like knowing that they’ll be there if I want them.*”

In fact, several participants described their mobile devices as portals to online places: “*...the biggest change is I use my phone all the time to check things like Facebook and change my status, add new information and photos, and*

leave comments. ...it's as much a gateway to all my stuff online as [it is] a phone" (Bill-17).

In addition to being seen as portals to personal collections, key cases emerged in which mobile devices appeared to function as temporary storage centers. In several cases, participants reported storing photos on their devices, while waiting for the opportunity to transfer them online. *"If I take photos on my phone, I upload them right away and then usually delete [the local copies]. ...It's better because I feel like I know where they're at ...and they're always available"* (Michelle-16).

In general, participants perceived online services as providing unlimited and enduring storage: *"I store everything online. It's much safer than keeping it all on my computer. I mean it [computer] could just die, but if they're online, they'll be there forever unless I decide to take them down"* (Sherry-16). Interestingly, in a few cases, participants described how the transition to cloud storage resulted in a perception that they would require less storage on their mobile devices. For example, Derek-15 describes his decision to not to upgrade to a larger iPod, *"I was going to get a 32GB iPod but I don't really need the space. ...I stream music and movies from the web more now and upload most of my photos, so I thought I wouldn't fill it up."*

Evidence of participants' transition to the cloud also emerged when they discussed file management strategies. Bill-17 describes his shift in management practices: *"I still have my old folders where I keep things like homework assignments, music, photos, my diary... but aside from music and sometimes photos ...I've been putting most new stuff online for the past couple years."* Several younger participants had never adopted concrete practices for organizing local files: *"I always try to get my files and stuff online first. Then I delete them or put [files] in a folder where I kind of keep them all ...I don't go back there [in local folder]"* (John-14). Similar to John, it was apparent in several cases that participants maintained only a single or small subset of local backup folders in which their varying types digital content was inconsistently dumped together.

Participants both implicitly and explicitly expressed desires to be able to move their digital possessions to the next place they were going to be; several drew on their email accounts as a workaround to transport things such as photographs and accompanying annotations, video, personal artwork, personal notes and diary entries, presentation slide decks, homework assignments, and, in a few cases, personally meaningful text messages. For example, Chris-16 reflects on how self-emailing provided the opportunity to privately access his journal, music files, and homework across school, home and friends' houses, *"it's the only way to know I have something saved and only I can access it. ...I'll email myself journal entries in Gmail and later tag and archive them. ...I'll send music files so I can play them at a friends' house if I don't have my iPod or I want to give them [the songs]. ...all of my friends and me, we email our*

homework assignments to ourselves. ...[this way] I can work on them for a while, like on at school, and then later at someone's house or on my laptop at home."

Digital technologies and presentation of self

Most of our participants regularly interacted with their virtual possessions in order to manage their presentation of self to multiple audiences. In what follows, we describe how value emerged through redecoration; how the curation focused on different audiences; and tensions around constructing multiple digital selves for different audiences.

The display and organization of possessions in teenagers' bedrooms play significant roles in shaping their evolving sense of self. The presentation of trophies, photo collages, and posters of popular culture icons, among other things, shape teens' perceptions of who they are and who they might become [31]. In this way, the bedroom presents a material infrastructure that teenagers can exert control over in order to experiment with their identity. For example, Julia-14 had an equestrian theme permeating her room, where many of her possessions (including bedroom wallpaper) directly related to riding horses. However, she had recently lost interest in horses and made plans to redecorate her room in a more "mature" way. She also had constructed a shrine to the teen celebrity Nick Jonas that had moved from being present in her room to being inconspicuously stored in her closet. Most participants shared stories of how their shifting tastes created a continuing re-authorship of their bedroom.

Several cases emerged in which participants shared how they customized mobile phone, personal media player, gaming console and personal computer display backgrounds to reflect their shifting tastes. We observed a diverse collection of background images including friends and family members, celebrities, music and popular culture imagery, personal avatars from online games, and physical artifacts symbolic of favorite hobbies. In contrast to the relatively slow rate of change in display of material possessions, in several cases virtual possessions populating backgrounds appeared to change frequently (from weekly to, in a few cases, several times a day): *"My laptop background is usually something really important to me, like a picture of my girlfriend, or right now it's an image of where I want to go [to college]. It's like that because I'm the only one that looks at it. Same with my phone. ...but my Playstation, that I download new skins for all the time. ...since I play [it] with my friends. ...It's usually some kind of skin that's from a game or a movie we all like"* (Bill-17). Similarly, Sarah-13 described a habitual practice of reflecting on her mood and recent likes and dislikes, and subsequently searching several bookmarked popular culture and graphic design websites to find new backgrounds for her computer and mobile phone weekly. She claimed that, *"everything on my technology must represent me. ...I change what I like and how I feel a lot, so they change too."*

While the bedroom was a key site for identity experimentation, the presentation of some key possessions conflicted with the social and moral structure of the home, and several participants discussed their inability to display posters or to listen to music their parents found to be in conflict with family rules and values. However, several key instances emerged in which participants described feeling considerably more control over social networking sites. Michelle-16: *"...in my parents' home, there are things I can't exactly put up in my room. ...and things that've caused problems when I've tried (laughs). ...[like] photos of me and my boyfriend. He's older and my parents don't like it, so they won't let me have photos of us here [bedroom]. ...but on Facebook I have control over what goes up about me and what it says. ...and I recently added lots of photos with my boyfriend there."* She further elaborates on how Facebook provides a place to store and present contraband digital objects, *"Almost everything here [bedroom] is important. It all represents me. ...but there's also stuff that I could never have here ...Mom would kill me. ...a lot of it ends up on Facebook: photos and messages of [myself and friends] out being ourselves. ...I put it there because it's me, but a part of me I don't need to share with everyone."*

These reflections help illustrate how of the display of virtual possessions in online places enabled some of our participants to experiment with crafting and presenting different aspects of their self to different audiences. In these cases, participants frequently used the services' privacy settings to demarcate groups, allowing particular possessions to be viewed by certain audiences. Many participants reflected on how making their status messages and specific groups of photos accessible to only friends (e.g. as opposed to parents) shaped the way they framed their online content. For example, Suzy-17 stated: *"I have lots of Facebook 'friends' like my friends' parents and random people I meet. But only my close friends get access to everything. ...I would like other people to see some of my stuff or updates, and there's a way to do that, but it's hard to figure out and I don't trust it, so I have to choose one [group] and with them [close friends] I'm most my self."*

We also encountered instances in which participants indicated information they made available to everyone (e.g. parents, family, etc.) on their social networking sites was frequently shaped to reflect relatively mundane aspects of self. For example, Frank-16 describes his decision to only contribute new material perceived to be 'safe' in the context of all his social groups: *"I want my relatives and other people to still know some things about me so I made my [status] updates public and end up posting pretty harmless stuff... [like] cheering for a sports team or 'passed my test'."* Despite efforts like this, we encountered other participants that described tensions emerging from accidentally sharing personal information too broadly. A classic case of this is reflected in Bill-17's description of his mother and grandparents viewing inappropriate images of him at a late-night party, *"I got tagged in some pics from a party. ...they*

were full of things that would've been fine for my other friends to see. But, it was terrible for like my mom and grandma to see them. ...I had to stop going out for a while and I stopped using Facebook for a long time. ...it totally affected my social life." Laura-16 reflected on how the emergence of photos of her and her new boyfriend complicated other relationships: *"...it's a big step to be tagged together in photos [on Facebook]. ...I put some [photos of self and new boyfriend] up and thought they were restricted to [us], but they ended up being visible to lots of people like my ex and a lot of his friends that we'd see together. They all were unhappy. ...I untagged myself from most of the photos and ended up deleting some "*

We also observed tensions around boundaries of social appropriateness, such as when parents added comments to their children's social networking pages. For example: *"I can try to control who see's what I put on my wall, but it's hard to control who sees the posts and comments from different people. ...My Mom posts on my wall all the time and I don't want my friends to see it. ...I guess I don't always want her to feel like she can't Facebook me. ...but my wall, where everyone can see, isn't the right place. I usually delete [Mom's posts] when I see them"* (Mary-16). Similar to Mary, a handful of other cases emerged in which participants reported deleting posts or comments from family members (usually Mom or Dad) and in some instances later contacting them through the phone or email.

The ability to fluidly craft a targeted presentation of self through privacy permissions emerged as a rich resource to strengthen a sense of social connectedness among several of our participants and members of their different groups. At the same time, a lack of more usable and sophisticated privacy considerations resulted in numerous embarrassing and regrettable experiences. These instances tended to amplify the tensions among social groups in participants' networks, which often motivated them to remove or, in some cases, permanently dispossess certain virtual possessions by deleting them.

Personal and group attributions of social metadata

Metadata emerged as a defining aspect of virtual possessions. It provided a platform for users to collaboratively and individually personalize a possession, as well as relationally link multiple types of virtual possessions together. Below we describe how value emerged as virtual possessions acquired metadata.

In some cases, new value emerged as photos documenting a specific event or experience, once shared online, accrued social metadata; the ability to create metadata appeared to support collective reconstruction and revisitation of shared experiences with friends and family members. For example, Kate-16 describes how this activity served her desire to develop a more 'real' representation of an event: *"I bring my camera with me whenever I go out with my friends. We take lots of pictures. ...When I get home I upload them. Then I tag most of my friends [in the photos]. ...and we all*

tag and untag other people and post comments. ...[we] delete the ones that we don't need ...the ones that don't get a lot of comments or don't seem as good as the others." She continued to describe how this attributed a layer of realism, *"It feels like a more authentic representation of the event ...we comment and agree on everything together. ...then there's a shared sense of what happened."*

We also observed how participants used the "tag" function in Facebook to define a set of friends that extend beyond the people in a specific photo. *"We tag people that aren't in our photos all of the time. ...it's a way to get their attention and get them to comment on the photo or, if they don't, at least linking you all together. ...you're showing something happened that made you think of them. ...maybe when you were there, or maybe it reminds you [of them] later when you see it online"* (Mary-16). These comments collectively highlight key ways in which value appeared to surface through the use of metadata. For Kate it involved a deeper sense of authenticity that emerged from collaborative curation, while for Mary, value came from reinforcing an affiliation through sharing. In both cases, value emerges from the creation of the metadata instead of the creation or exchange of the initial artifact.

In addition to photos, participants engaged with metadata related to music. Interestingly, several instances emerged in which participants described giving and receiving musical playlists as gifts, and sometimes modified metadata as a part of the gifting practice. For example, Frank-16 described his practice of replacing album art images with photos from events he attended with his girlfriend, *"Now, before I give her a mix [CD] of songs, I go in the info and put a photo of us together. ...at least it'll come up on her iPod and it makes it different in her library from everything else."* Derek-15 also reported editing mp3 metadata to include personal notes in playlists given to his girlfriend in hopes that one day *"she would look there and find something special."* These reflections highlight the challenge of making a gifted virtual possession stand out among an ever-increasing collection of similar things, as well as strategies employed to make gifted music more unique and particular to the receivers.

Finally, we encountered various cases in which participants' music collections encompassed all of the music they had ever owned, and, in some cases, expressed strong reluctance to delete songs or albums they no longer listened to. Despite our population's young age, these kinds of collections typically represented several different life stages, at times evoking experiences of reflection on past taste and current preferences. They also to some extent mimic the collections of data common to adults who have vast backups of email, etc. In this case, the systems created metadata detailing when and how often songs had been played; metadata participants could use to examine who they were. For example: *"...I have stuff I listened to when I was really young and what I was listening to in middle*

school, and I'm what listening to now. ...the things I like change and I change too, and it's interesting to see how you've changed through how often you listened to things and when you last did" (Kate-16). In contrast to Kate's case, a few participants described how these archives and records evoked reflection on more melancholy aspects of past experiences. Nonetheless, across these cases, machine-produced metadata did appear to provide rich resources for reflection on one's self and for re-visitation of past selves.

Transition between material and virtual forms

We observed several examples of possessions transitioning between material and virtual forms. In what follows, we first describe how participants physically displayed their virtual possessions. We then present examples of how material possessions took on a digital form in order to move beyond the constraints of a single bedroom.

A key factor differentiating virtual and material possessions is that virtual possessions lack a lasting material form. Interestingly, we observed some participants compensated for this by keeping their computers, mobile phones and media devices always on and connected to their collections of virtual things. There appeared to be several related motivations to this behavior. Kristen-16 described methodically encoding albums in her music collection with the appropriate artwork and always projecting these images through her computer screen to amplify the material presence of her digital songs, *"so it feels like it's more than an mp3 ...it's there reminding you what it is. ...but you can easily ignore it too, like anything else around [my bedroom]."* Suzy-17 similarly kept her desktop monitor on to display photo collections stored on Facebook: *"They're different from the ones on my computer [hard drive] because online they have what my friends' said and the links they posted. ...that's all part of the [photos] now and I want it all there together."* James-16 describes his desire to be on Facebook as frequently as possible; when in his room he reported often simultaneously accessing his account through his phone, iPad and laptop: *"I like to be logged in to my laptop and iPad so I know when something happens, like someone writes on my wall or a photo or tags me. ...I want to see it around me. ...way better than getting a text [message] or an email about it later. ...it keeps me up to date with everything going on."* Collectively, these practices highlight several of our participants' desires to fluidly move between the material and virtual world.

We also encountered instances in which participants printed and displayed their virtual possessions within their bedroom. In particular, numerous participants had printed out cherished photographs from Facebook, often constructing large collages. For example, Kate-16 compares her previous practice of making collages with photos she had taken to her current practice of compiling assemblies from various shared albums online: *"I like them better because my friends' personalities come out in their pictures. ...sometimes I'll be looking at one and think about*

what I wrote or what my friends' wrote [on them online]." In a rather extreme instance, Michelle-16 described printing and archiving her favorite Facebook photos in a scrapbook, often along with notes documenting the associated metadata, *"I pick the best ones [photos] from an album ...usually they have comments on them. ...[I] write them down on notes next to the photos [in the scrapbook]. When my friends come over we look through it and add new things when we feel like it."* We also encountered an interesting case in which Derek-15 had printed excerpts of his friends' status messages and chats to display in his room; he conveyed a desire to be surrounded by them as, *"they represent my friends and much as my photos."* In these instances, participants reported these virtual-made-material possessions had served as focal points for reminiscence with friends or family when in the bedroom.

We encountered other instances in which participants used photos to make digital copies of material possessions that were typically constrained to the bedroom. These material-made-virtual possessions could accrue additional value through socially constructed narratives that emerged outside of the home; examples included trophies and certificates, artifacts associated with hobbies, and self-made artworks. Bill-17 provided an exemplary case in his description of uploading digital copies of several hand drawings he made of his Halo avatars: *"Lots of people 'liked' and commented on them ...the digital [copies] are different because you can't hold them, but it's meaningful because all these other people never would've seen them and wrote on them. ...some people left comments about how it's so 'me' to draw my characters ...some gave me artistic advice; [they] like left links for me to look at, and some just thought they were cool. ...those things, what people posted, are important. ...now I think about them when I look at [the original drawings] in my room ...they're definitely something I'll keep."* Instances we encountered, such as Bill's, highlight how interactions across social groups in online places jointly inscribed valued records of metadata into collections of possessions; and, similar to this case, shaped how material possessions themselves were perceived.

DESIGN OPPORTUNITIES AND ISSUES

Our findings show how virtual possessions and online places create new opportunities to support identity construction and experimentation, to re-enforce old and shape new social connections, to develop deeper meaning through shared and personalized use, and to support re-visiting perceptions of one's past as a way of reflecting on the current self. We also found several participants fluidly moved themselves and their things between online and material environments without needing to clearly demarcate boundaries between the two. These findings suggest several opportunities that can aid designers in generating new forms for virtual possessions and new interactive systems to engage with these things. They also raise a range of potential unintended consequences and paradoxes [22] that could easily emerge if designers blindly make new products

and services. Through repeated discussion and modeling sessions of our findings, we identified three specific opportunity areas for investigation by researchers and practitioners: *accrual of metadata*, *placelessness and presence*, and *presentation of selves*. We also highlight several potentially negative consequences that should be considered when working in this emerging space.

Accrual of metadata

One unique quality of virtual possessions is their ability to accrue metadata over time. In some cases, metadata itself became a valued virtual possession; in others, it appeared to be an element indivisible from the original artifact. Across all these instances, value appeared to emerge as different types of metadata enabled participants to craft and keep social histories; something that had been considerably less explicit in a world filled only with material things.

Prior research [e.g. 9] has described how material artifacts take on particular qualities that make them meaningful, such as the books parents read to their children at bedtime and grow attached to. On the surface, this seems less achievable for virtual things as they are infinitely reproducible and lack an inherent ability to gather a patina from age and use. Interestingly, we observed participants encoding new elements into virtual possessions (e.g. music collections, digital photos, textual annotations), to make them more uniquely self-expressive, or to share experiences with others. We also found machine-produced metadata (e.g. timestamps, frequency of use) provided a valued resource for connecting a thing to particular experiences. These instances suggest an opportunity to design technologies that enable users to encode a more diverse range of content into virtual possession metadata, which could shape the resulting digital artifact to be more reflective of an individual or group. For example, virtual possessions associated with a particular event could be encoded with things such as the aggregate status updates of a person when last in the event location, songs most frequently listened to during the event, or perhaps personal messages or other forms of content associated with the event that would emerge as these digital objects are interacted with over time. We imagine interactive systems could also provide richer ways of contextualizing experiences associated with virtual possessions through aggregating various types of metadata from online resources, such as weather information, or local and historical news events associated with the place in which the event was held. Previous research [e.g. 13] has illustrated the value in converging streams of 'ready-made' online information onto collections of digital objects to evoke rich, personally meaningful experiences. In general, there appears to be a large opportunity in combining human and machine-created metadata to construct more expressive assemblies of virtual possessions that evolve over time.

We also found the ability to attribute different types of metadata to virtual possessions in shared online places in

some cases supported practices aimed at developing a more ‘authentic’ collective understanding of an event. New value also appeared to emerge as metadata was used to extend an artifact beyond its original content, such as linking it to other people, places, possessions and experiences. These instances illustrate how storage and presentation of virtual possessions in online places opens a space for new value to emerge from sharing, editing and, ultimately, the collaborative construction of social histories focused on virtual things. These practices collectively model Belk’s [5] notion of *sharing in*, where people share within a social group as a way of strengthening bonds. Importantly, similar to how people can extend their sense of self through possessions, this process of extending permissions to present and edit (or collectively ‘own’ rights to edit) particular possessions with others plays a key role in extending individual sense of self *through* other people [5, p. 726]. Offering the opportunity for collaborative curation of virtual possessions in more nuanced and extensible ways appears to be a rich space for further investigation.

Finally, the value of social metadata is not limited to only virtual possessions. We observed some cases in which participants virtualized their material things to make them available to targeted audiences beyond their bedrooms. At times, these things appeared to increase in value through accruing metadata; interestingly, as in the case of Bill’s Halo avatar drawings, they seemed to shape some participants’ perceptions of the material artifact. This suggests a significant opportunity area for designing systems for managing virtual proxies of material artifacts. These systems could collate information related to a particular artifact (e.g. locations, time and frequency of use, social audience(s) present, social metadata) to create rich personal or shared histories of a thing. We imagine they could provide valuable virtual resources shared across members as families expand and heirlooms are fragmented across multiple homes, as well as enduring social records of treasured material possessions forever lost or destroyed. Future research could scaffold and extend recent work exploring tangible interactions with digital copies of familial artifacts [18] and digitally augmented physical mementos [24, 27] to investigate how virtual proxies (and virtual possessions in general) could be embodied to support interactions with individuals and groups, as they move in and between virtual and material environments.

Placelessness and presence

One clear value for many material possessions comes from the fact that people can display them, such as a collection of books on a shelf in a bedroom. We observed it was difficult to make virtual possessions’ presence dynamic and enduring in a physical place; however, they could be made temporarily present in nearly any location. This quality of placelessness provided teenagers with a feeling that their collections of virtual possessions could travel with them across social and physical contexts. While our population had less time to acquire expansive archives of virtual

possessions as compared to older populations, it was clear many had a significant desire to ubiquitously access and amplify the presence of their virtual things. Several of our participants drew on social networking sites and email accounts to move and access their virtual possessions as they moved about their day; several also appeared to frequently use mobile devices as portals to their online places. In general, our participants reported valuing the ability to ubiquitously draw on their virtual things across contexts, and instances emerged in which they appeared to use this ability to breakdown boundaries between material and virtual worlds, and to move fluidly between them.

Clearly, current services for uploading, storing, and interacting with virtual possessions are insufficient. The breakdowns shared by our participants collectively point to a desire for a new kind of cloud computing that unites disconnected services, making it easier to move and access virtual possessions stored in different online repositories. There also appears to be an opportunity for designing storage systems that enable a single virtual possession to be more easily shared and made present across multiple places, and which stores archives of multiple layers of metadata as these virtual things acquire new annotations. Issues for designers include how to communicate the size of virtual possessions, and changes that have taken place as they acquire new history. For example, a digital photo frame could explicitly show metadata associated with an image; this kind of display could provide a map of a virtual possession’s shifting statuses as it acquires “digital patina” through new attributions. Past research has speculated that as digital collections grow, more meaningful experiences will likely arise from collating and contextualizing smaller groups of content, as opposed to archiving every aspect of a person’s digital life [27, 28]. We think it pertinent to design tools to support the cultivation of virtual possessions into valuable and accessible assemblies as collections expand.

Finally, several of our participants’ practices of uploading and accessing their virtual things through multiple online places and devices contrast to some extent earlier work investigating how meaning emerged for teens through the ritual exchange of text messages and their embodied presence on a specific phone [32]. As virtual possessions like archives of SMS messages, social media content, and digital photos are stored in various online places and accessed through multiple devices, key opportunities lie in exploring how new form factors and expressive materials might extend embodied interactions across platforms and environments in meaningful ways. In general, this area suggests more research is needed into understanding people’s *immaterial* practices with and perceptions of virtual possessions across space, time and technical platforms; and how this knowledge might shape how virtual things are given form in material environments.

Curation and presentation of self to multiple audiences

We observed a range of ways in which our participants drew on virtual possessions to personalize technology and to project shifting tastes and identities to different audiences. Background images on mobile devices were frequently modified; in some cases, new content was actively searched to reflect evolving interests. Social networking services such as Facebook appeared to function more as a “place” where participants exhibited fluid control over expression and curation of different aspects of their identities. In several cases, the ways in which virtual possessions were framed and presented varied depending on the social group(s) that had access to them. These findings highlight how the management and presentation of virtual possessions in online and offline places offers key opportunities for creative experimentation with one’s sense of self. In particular, the ability to attribute access privileges to specific virtual possessions appeared to be desirable. In several cases, this strengthened social connections to members of different groups by highlighting unique social bonds. However, significant complications also emerged from the accidental presentation of virtual possessions to a social group (or groups) they were not intended for.

These findings suggest an opportunity to design environments that are socially reactive to the groups that are present, or to create better ways to select aspects of self to project to these different groups. For example, a system could respond to the audience present and context in which it is being used to automatically generate an appropriate display. More broadly, it is clear that current tools people use to manage online privacy are deeply underdeveloped. Opportunities exist to design systems that enable end users to create displays of multiple aspects of self to be delivered to different audiences, which extend far beyond the current model of managing permissions. This could lead to more complex and expressive assemblies of virtual possessions that, in turn, project more socially appropriate and meaningful aspects of self to particular audiences.

We also found several participants fluidly moved between material and virtual environments and appropriated various everyday materials in attempts to breakdown barriers separating these two worlds. We imagine there may be opportunities in leveraging the relatively more flexible nature of online places within intimate material environments. For example, we envision one context to explore the potential consequences of this direction is through the design of a socially reactive bedroom that enables teens to easily display and curate virtual possessions and attendant metadata; that allows them to create new metadata and see when it is created by others; that transforms displays based on people present in a room, surfacing things they have in common, or perhaps making the room “Mom Approved” when a parent is nearby. We imagine a series of technology probes in this area could produce new knowledge into dimensions of social

appropriateness of this opportunity area, and open the space for richer exploration in and beyond the bedroom.

Probing potential paradoxes and consequences

While there are many opportunities to re-imagine the forms of virtual things to increase their perceived value, it is important to critically consider possible negative outcomes. As form givers of technical systems, HCI researchers and practitioners must recognize requirements emerge from complex interplay between technology and users, as opposed to pure technological advancement [12, 22, 32]. When approaching this space the community should keep in mind the complexities of dispossessing virtual things and persistent virtual records, as well as potential negative social obligations and expectations that could emerge.

People actively reinvent themselves by selecting which elements of their past to keep and which to let go [20, p. 9]. While virtual possessions can play a potentially important role in supporting identity construction processes, how one might *dispossess* a virtual thing is unclear. For example, shared (and co-curated) possessions could pose problems, as consensus is required across various members on dispossession. Users will need to be able to richly experience sharing their virtual things with different social audiences, while having the flexibility to retain control over rites to (dis)possession. Moreover, the persistent archiving of virtual possessions over time offers new opportunities to support reflection on life experiences; however it also creates an exacting history of who we are, leaving little space for romanticizing about the past and forgetting experiences we no longer wish to relive.

While virtual possessions can increase a sense of social connectedness across individuals and groups, they could also work to amplify differences and reinforce cliques. New technologies for presentation of virtual possessions could provide people with valuable portraits of their identity; however, they equally could promote self-obsession through creating the ongoing obligation to curate multiple selves. Accrual of metadata opens a new space to construct virtual possessions more uniquely reflective of particular experiences, while also possibly creating new social expectations to continually create these attributions. These issues must be considered and could serve as productive framing mechanisms for future research as researchers and practitioners move forward in critically determining socially appropriate and beneficial design interventions.

CONCLUSION AND FUTURE WORK

We have explored how our teenage participants perceive, value and form attachments to their growing collections of virtual possessions. A goal of our paper is to surface key issues and opportunities related to our audience’s interactions with virtual possessions to critically consider the benefits and potential dangers of designing new technologies that might enable people to find more value in their virtual things. Our fieldwork presented several complications participants faced when presenting and

interacting with their virtual possessions in online spaces, and key strategies employed to engage with their virtual stuff in valued ways. Based on these findings we proposed *accrual of metadata, placelessness and presence, curation and presentation of self to multiple audiences*, and *probing paradoxes and consequences* as an opportunity map to guide future research and practice in the HCI community.

A clear limitation of our study is that all of our participants had frequent access to technology and hailed from middle and upper middle class families in the United States. Participants from different socio-cultural and economic backgrounds represent significant populations and would potentially produce alternative results. This suggests opportunities for future cross-cultural investigations into how different groups construct value with their virtual things; and how these processes unfold within populations representing different ages and economic backgrounds. Our findings do raise several issues about the social appropriateness of new technologies. We are currently developing technology probes based on these opportunity areas to critically explore such issues. Ultimately, we hope this study inspires future research into how technologies could be designed to engage people with their virtual possessions in more valuable and values-oriented ways.

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