

Personal Inventories in the Context of Human-Computer Interaction and Environmental Sustainability

William Odom

School of Informatics, Indiana University Bloomington,
wo@willodom.com

PROBLEM AND MOTIVATION

Interactive technologies and systems increasingly populate contexts of everyday life in the industrialized world, and the home in particular represents a key site of consumption. The field of human-computer interaction (HCI) continues to lead to significant advances in making domestic interactive products more usable and pleasurable. Moreover, these digital artifacts exist in many of our intimate settings, representing important signifiers of human relationships; they communicate stories about us and help construct notions of who we are and want to become. Nonetheless, such interactive technologies are typically impermanent in our lives and discarded far before their functional lifetimes have expired [1, 3, 8]. This accelerated cycle of consumption and disposal of digital artifacts is described by Huang and Truong as a “*disposable technology paradigm—characterized by technology that comes with the expectation of short usage lifetime, despite the potential for a longer functional lifetime*” [8, p. 323]. The wide-ranging effects of such short-lived usage continue to result in substantial contribution of toxic materials to the global waste stream [1, 3], which present serious implications for our collective human and environmental futures. Thus, while worthwhile, simply including less environmentally damaging materials in the design of interactive technology products is unlikely to be sufficient; as T. Cooper writes, “*there is a need to slow the rate at which raw materials are transformed into products and eventually discarded*” [3, p. 54]. Apropos the material effects of the disposable technology paradigm, it is essential we develop new ways to extend the longevity of the digital technologies and systems that we create.

In this paper, and my ongoing research, I am specifically concerned with the question of why we preserve some things and discard others. I am trying to understand this question particularly for the context of interactive technologies and their connection to sustainable practices—that is, how this knowledge might inform the design of potentially more *enduring* technology. In what follows, I first briefly develop a theoretical perspective and framework for understanding this problem. Next, I describe and apply this framework to interpreting 3 key case instances uncovered in fieldwork, which involved a method of collecting *personal inventories* of digital and non-digital objects in peoples’ homes. Finally, design principles are postulated for which the field research provides some

evidence and which are intended to further future research and discourse in the context of HCI and Sustainability.

BACKGROUND & RELATED WORK

Theoretical Framework

When addressing the question of how people relate to objects in their everyday environments, it is possible to build on several theoretical foundations. The majority of HCI research to date draws on psychological research, and the book “*The Meaning of Things*” [4] is well cited as a seminal work and core influence. However, a far less utilized perspective for framing HCI research exploring relationships between people and objects comes from philosophy of technology. As such, contemporary philosopher of technology Peter Paul Verbeek is a core inspiration and theoretical source for this study. As a design theorist, Verbeek has greatly influenced thinking about technological products in general in terms of what makes some things enduring, while other things are easily disposed. In [12], Verbeek distinguishes three design perspectives that affect durability. The proposed framework in this paper is based on taking these three perspectives as factors for analysis of collected field research, which are:

1. Function—what an object does. In Verbeek’s terms, the functionalist perspective refers to the traditional industrial design notion that a “*product must first of all be functional; it must do what it is designed and manufactured to do.*” [12, p. 204].

2. Symbolism—what an object means. In Verbeek’s terms, the semiotic perspective refers to another traditional industrial design notion that “[a product] *has meaning or sign-value: human-beings are drawn to particular product styles and not to others, and use a product to express the lifestyle to which they (want to) belong.*” [12, p. 204].

3. Material Qualities—what an object is made of and its broader sensual appeal. In Verbeek’s terms, the material aesthetic perspective refers to both materials as mediators of the relationship between people and things, and to “*the sensorial in the broadest sense*” [12, p. 211]. In Verbeek’s treatment, the material aesthetic perspective is part of a more modern philosophical perspective of technology, an “*approach which aims to make a contribution to the ongoing discussion of environmentally sound design*” [12, p. 204].

Verbeek emphasizes material qualities over symbolism and function as explanation and prediction of durable relationships between people and things. This point is central to understanding Verbeek's writing. In contrast to an overt focus on function and symbolism, the material aesthetics approach emphasizes the importance of designing to direct attention towards the particular material object itself (in this case digital technology), rather than solely what it provides in terms of its utility, or what it refers to in terms of meaning. Verbeek further writes: "*The bond that arises between people and products will have to concern the concrete object that is present in the here and now, and not only the meaning or symbols it carries or the functions it fulfills.*" [12, p. 225]. Thus, utilizing material qualities as a factor for analysis is significant in part because it is so deeply implicated in the way in which our relationships with things are mediated by means of the choices of material qualities in design. I here am strongly drawing on and stressing the importance of Verbeek's work as his emphasis on material qualities targets and scaffolds a perspective of sustainability—one that has not yet been presented and interpreted in the context of HCI research.

Sustainability & Related Literatures

The research presented in this paper contributes to nascent and growing efforts in HCI and computer science to link sustainability with interactive technologies. Blevis [1] introduces the notion of Sustainable Interaction Design and lists and describes prior related and motivating literature. The 2008 and 2009 Computer-Human Interaction (CHI) conferences presented several papers on the topic [e.g. 6, 8] and several panels and special interest groups [e.g. 9] have also occurred. In addition to the CHI venue, recent UbiComp [7], Pervasive [5] and System Sciences [10] conferences are beginning to explore the role computing technology might play in helping achieve a more sustainable future. To date, the majority of this research has focused on building interactive devices and systems aimed at persuading users to behave more sustainably, often by consuming fewer resources such as electricity or water [e.g. 6]. These contributions are no doubt worthwhile and more research is needed in this area. Nonetheless, considering the complex and diverse challenges associated with achieving more sustainable ways of being and the recent uptake of sustainability as a area of inquiry within the ACM research community, what is also needed are proposals suggesting alternate ways in which sustainability-oriented research might be constituted and framed. Such proposals—and ensuing scholarly discussion—will help support and cultivate the foundation from which future work will emerge; this research aims to contribute on this level through the unique interpretation and application of a perspective from philosophy of technology in the context of HCI-oriented fieldwork.

UNIQUENESS OF APPROACH

The *personal inventories collection* is a method developed in order to better understand why we preserve some things

and discard others and factors affecting attachment to digital and non-digital things. The purpose of establishing this method is to make it possible to unpack these complex processes in a systematic way that could inform and inspire technology researchers and designers. The development of this approach owes to a variety of prior work and inspirations spanning multiple disciplines; its origins are described elsewhere in an ACM Interactions article [11]. Over the course of this study personal inventories were conducted by the author in 22 separate homes with 26 participants, of whom 16 were women and 10 were men. Participants were recruited from a Midwestern US city, which offered populations representing major consumer demographics with respect to digital technology. Although these participants ranged in age, all were adults and exhibited a range of occupations (e.g. teacher, artist, system administrator). The inventory sessions lasted between 2 to 4 hours and consisted of conducting in-home contextual interviews to probe participants' reflections on their likes, loves, and dislikes with respect to digital and non-digital things they own, with an eye towards key factors shaping strength of attachment to these things. This study produced rich data consisting of handwritten field notes, audio recordings, and several hundreds of photographs. Audio recordings were listened to and relevant segments transcribed. These relevant portions were then organized into themes and textual and visual documents were coded using these emergent themes.

RESULTS & CONTRIBUTION

The relationships between an object, a person, and that person's attachment to an object are complex. In what follows, key case examples are reported that highlight both the complexities of these relationships and suggest opportunities for designing digital technology products that could engender a higher strength of attachment. Nonetheless, general relationships that appear strongly correlated with and characteristic of strength of attachment did emerge from data analysis. In particular, findings are clustered into 3 areas denoting relationships between owner and object, namely

1. **Engagement**—the extent to which an object invites and promotes physical engagement with its owner during use;
2. **Histories**—the extent to which the materials of an object preserve personal histories or other memories, either by explicitly showing physical signs of use or implicitly by virtue of its persistence over time;
3. **Augmentation**—the extent to which an object has been reused, renewed, modified, altered or otherwise made to be a part of something augmented beyond its original intended use and as such has become a symbol of the resourcefulness and/or creative expression of its owner.

For each of the relationship clusters, a brief overview of findings is presented followed by a detailed description of one key representative case (due to space considerations).

Engagement: Overview

The kinds of things found which endure in part due to engagement included, among other things, a figure modeling set (P18), socket wrench set (P19), saxophone (P7), and typewriter (P3). These specialty tools each require a degree of skilled use and direct physical involvement; participant responses illustrated deeper attachment to these objects. Contrastingly, in what immediately follows a detailed example is presented of an everyday electronic object that did not require skilled use, but nonetheless resulted in deeper attachment by virtue of materially engaging interactions.

Engagement: Wind-Up Flashlights

Wind-up flashlights appeared across three inventories and represent a distinguished example of an object of engagement.

Strength of attachment: The three wind-up flashlights encountered in this study were described in terms of strong attachment by their owners (P5, P19, P20). For example: *"I immediately loved this one; it's one of my favorite things in the house"* (P5), *"It's so cool!"* (P19), and *"Absolutely! [I prefer the wind-up flashlight]"* (P20). **Function:** Participants principally attributed the emergent strong feelings of attachment to the unique function of the flashlights. In particular, participants found functional value in (i) the convenience and monetary savings resulting from not having to purchase and replace batteries (P20) (ii) the increased reliability of the flashlights—for example, P5 stated: *"The crank makes it easy to produce light and I could go anywhere with it."* and, in one particular case (iii) the ability to charge other electronic devices with the charging mechanism of the flashlight—for example, P5 stated: *"I sometimes use it to charge our [her and husband] cell phones. I plug it in [a phone] and start to crank; it starts charging just like that."* **Symbolism:** With each of the three participants, attachment to the flashlights appeared less strongly related to symbolism. The participants made no reference to how this product reflected their interests, lifestyles or values. **Material qualities:** Material qualities again played a key role in facilitating meaningful attachment, which is reflected in the apparent delight P19 expressed in the increased function resulting from generating power by hand—*"It's so cool! Look... [winding up flashlight] it doesn't need batteries!"* On a deeper level, P5 describes an intimate bodily understanding of and connection to the material device and power generation—*"I think about it [flashlight] when I'm charging the phone and how my energy is going into the phone. ...Sometimes I think about it [the phone] when I'm using it. ...I guess feel more connected to it [the phone], you know, how my body recharged it."* **General interpretations:** Rather than being perceived as a burden, participants felt there was added value in the functionality provided by the self-sufficient hand-powered models. This situation represents an exemplary instance of an electronic product involving users directly in its functionality by virtue of the nature of the

direct, sensorial interaction with it. Moreover, in the case of P5, an unintended interaction emerged, modeling a nurturing process, potentially endowing a common electronic device with deeper meaning and attachment.

Histories: Overview

The kinds of things found which endure in part due to histories included, among other things, artwork (P11), a firearm collection (P22), a jewelry box (P3), a music box (P2), a pewter squirrel nutcracker (P7), and record collections and a Turkish Eye medallion (P16). These heirloom objects were of great importance to study participants; they had implicitly acquired histories as they passed between people through space and time. Nonetheless, the majority of these objects were no longer in frequent everyday use. In what follows, an example is presented that highlights a non-digital object that acquired a rich history, while still remaining in use—representing an exemplar of high strength of attachment resulting from strongly interwoven characteristics of function, symbolism, and material qualities.

Histories: Film and Digital Cameras

Across the inventories conducted in this study, multiples of particular devices were commonly encountered, often with contrasting digital and non-digital objects. While most digital objects had not been in possession as long as the non-digital ones, participants' responses indicated digital objects generally did not show signs of attaining similar histories. In particular, an illustrative a set of film and digital cameras—containing objects both with and without rich histories—emerged as a compelling case.

Strength of attachment: The participant (P9) was strongly attached to one particular film camera, which had been in his possession for over 30 years. However, she was not attached to the remaining cameras, which included four digital cameras. **Function:** The strong attachment to the film camera was related to its function. The participant indicated that this camera still functioned well and that she continued to use it, albeit less frequently than in the past. This change in behavior was primarily because the digital cameras offered increased convenience. **Symbolism:** The strong attachment to the film camera was strongly related to its symbolism. The symbolism of the camera was described in terms of (i) its long history of use—over 30 years, (ii) the way this history of use represents the origins of the participant's passion for photography—for example, the participant stated: *"I got it when I became interested in photography during college. ...I still use it today"* (P9). In contrast, the digital cameras were not described by the participant in terms of symbolism. **Material qualities:** The participant's deep attachment to the film camera was strongly related to the material qualities of the camera. In particular, when describing why she continued to obtain digital cameras, P9 conveyed she was *"still looking for the right feel,"* which would be similar to that experienced with the film camera. Moreover, the film camera material richly

recorded histories that acquired symbolic value over time, *"My favorite thing about it is the leather [case], it's worn to fit the shape of my hand; it's kind of become a companion over the years."* **General Interpretations:** Digital products, such as the cameras in the previous example, did not seem to strongly encourage emergent material histories, perhaps partially due to plastic material generally not recording use as richly as leather or wood. Nonetheless, common digital products are often embedded with recording or data collection capabilities, suggesting a major, largely unexplored HCI design space.

Augmentation: Overview

The kinds of things found to endure in part due to augmentation included, among other things, materially-adorned cell phones (P13), a desktop computer and repainted bike (P14), margin notes to chess book (P3), a light-fixture fitted cabinet with an external controller (P15), and a lamp made from discarded coffee can components (P18). Generally, these objects were characterized by their owners' intentional modification and in many cases included materials augmented beyond their original purpose. This process relied on participants' varied skill sets and creative intuition to resourcefully complete such augmentations. In what follows, a case example of digital augmentation is presented.

Augmentation: Home-made Computer Device

Nearly all instances of augmentation encountered in this study were related to non-digital products. An important notable exception was a device P15 had constructed from a miscellaneous collection of computer parts.

Strength of attachment: The participant expressed strong attachment to this device, indicating that it was among his most loved possessions. **Function:** Attachment to this device was strongly tied to its function. The function of the device was primarily to service as a desktop PC, although the participant indicated that he was constantly exploring other uses of the device: *"After I finally finished it, I started experimenting with ways to use it other than my main [desktop] computer. ... Now we [roommates and P15] use it all the time in the house and I take it on long trips with me [in the car] to play music and movies. ... I have to use my other computer more, but this is definitely my favorite. ... because I made it from old stuff [i.e. parts] and it made me figure out new ways to use it [referring to desktop-model computer] that I had never thought of."* **Symbolism:** The participant's attachment to this device was also strongly related to symbolism. In particular, the meaning associated with the device owed to (i) the uniqueness of the device and the participant's personal involvement in its design and manufacture: *"At first I was interested in how I could use leftover parts that I had been holding onto for a long time. ... I had modified computers in the past, but this one felt totally unique. ... the stickers on it reminded me of my childhood; the case is from the first computer that my parents gave me."* **Material qualities:** The material

qualities of the computer hardware used in the device are relatively opaque in that they are difficult to understand based on material and sensorial interaction. However, to this participant these materials were understandable and, ultimately, craft-worthy for a concrete, functional purpose. **General Interpretations:** The participant's description of building this device and the subsequent experience-of-use was characterized not only by engaging with the device on rich material levels, but also by a deeper understanding of how this digital object could be integrated into his life in unique, intriguing, and, ultimately, rewarding ways. The fundamental impetus for and creative process through which material augmentation occurred in this example largely mirrored what we observed in non-digital instances. Nonetheless, the sophisticated technical knowledge required to augment the often non-transparent, inaccessible nature of computer technology might have prevented more widespread occurrences of digital material augmentation.

IMPLICATIONS FOR DESIGN

For technologists and designers who want to construct digital technology that could potentially inspire higher strength of attachment, interpretations resulting from this study suggest the following design principles are worthy of continued investigation:

Function—an object's function is more prone to obsolescence in the presence of new technologies than its symbolism or material qualities, in general. Nonetheless, a strongly single-purpose functional object is more likely to continue to endure if it has a strong sense of engagement, or relates to personal history, or can be used in a new way.

Symbolism—the development of an object's symbolism is harder to predict than the way in which it is likely to be used, the endurance of its function, or the lifespan of its material qualities. Nonetheless, symbolism can engender a high strength of attachment when it arises from personal history as a byproduct of use over time or when it arises from augmentation that reflects back on its owner in a personal way.

Material qualities—certain materials inspire durability, especially wood, or metal, and the perceived quality of materials in an object engender a high strength of attachment, in general. One could speculate that digital materials, especially those aspects of digital artifice that are not physical in nature, may be able preserve memories and can therefore afford the enduring qualities that other quality materials add to an object.

Similarly, the following design principles and questions are suggested for future research and discussion based on the three clusters of relationship properties that can also potentially motivate a high strength of attachment, and longevity and durability as a consequence, namely:

Engagement—as in the hand-cranked flashlight example, it is important to look for opportunities to increase an owner’s involvement in the motor-tactile nature of using an object for a function. How can we engender deeper and more aesthetically pleasing physical engagement with interactive digital products? How can such engagement lead to more useful and satisfying interactions with technology? What role might tangible computing and new forms of feedback play in facilitating digital-material engagement?

Histories—as in the patina that develops on the well loved objects such as the film camera, it is important to look for opportunities to use materials that can record in the form of patina or otherwise histories of use that enrich the attachment to an object rather than just cause the appearance of something that is used and needs to be replaced. In the context of digital devices, the data associated with a history of personal use could be used to establish a non-physical, or perhaps physical in some way to be imagined but certainly digital, patina which makes a particular physical computing device and its associated personal data history hold personal and nostalgic value. How can unique histories evolve over time and be tied to a particular object, increasing the significance of this object? How can signs of everyday use be represented digitally—either on a screen or through physical manifestations of digital information? Moreover, how can such emergent digital signs of use help contribute to ongoing narrative between an object and its owner or owners?

Augmentation—as in the computer constructed from salvaged and spare parts, the use of materials to reconstitute, reuse, renew, customize, or otherwise augment an object may lead to high strength of attachment. For example, materials like wood invite reconditioning with means like paint or varnish. In the context of digital objects, what is needed is more modular and reconfigurable and adaptable design of the physical components of digital artifact. In which ways can digital products promote resourceful and creative physical augmentation with respect to reuse, renewal, or customization? Established and emerging areas of HCI research—including end-user programming, modular computing, and DIY culture [2]—may consider the implications of their work in terms of product attachment.

CONCLUSION

Factors like function, symbolism, and material qualities as well as relationship properties like engagement, histories, and augmentation may be used by designers of interactive technologies as principles to guide the design of potentially higher strength of attachment digital artifact. Nonetheless, issues of longevity-of-use and digital technology remain complex and evolving. I plan to continue this research on an ongoing basis to further refine the design implications and theoretical understandings of why we preserve some

things and discard others. Through this work I aim to continue to expand the scholarly scope and foundation from which future sustainability-oriented research might grow within the ACM research community—ultimately as matter of critical need for more sustainable design.

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