

# A Sustainable Identity: The Creativity of an Everyday Designer

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## ABSTRACT

In this paper we explore sustainability in interaction design by reframing concepts of user identity and use in a domestic setting. Building on our own work on everyday design and Blevis's Sustainable Interaction Design principles, we present examples from an ethnographic study of families in their homes which illustrate design-in-use: the creative and sustainable ways people appropriate and adapt designed artifacts. We claim that adopting a conception of the user as a creative everyday designer generates a new set of design principles that promote sustainable interaction design.

## Author Keywords

Sustainability, everyday design, users, design-in-use, appropriation, ethnography, domestic.

## ACM Classification Keywords

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

## INTRODUCTION

We propose that reframing use and the user when considering digital artifacts or interactive technology for the home is one part of the puzzle of sustainability in interaction design. We make this claim based on our research into the notion of *everyday design* [35, 36]. *Everyday design* offers a formal lens through which to reconsider interactions with and the use of designed artifacts in the home. The *everyday designer* is a creative agent among other *everyday designers* who together create and redesign artifacts long after the products have left the hands of professional designers. We advocate that an understanding of the *user* that includes the notion of the *everyday designer* together with a new set of *design-in-use* principles offers a more sustainable approach to interaction design.

Typically, North American and Western European households are considered to be quite wasteful. In 2003-04,

the average waste in a United Kingdom (UK) household averaged 500 kilograms [32]. In the same year in Canada, the average waste per Canadian was approximately 380 kilograms per [30]. In respect to electronic waste, Gartner Inc. estimates that 133,000 personal computers (PC) were discarded each day by homes and businesses in the United States [7]. The Environmental Protection Agency (EPA) of the US government estimated that in 2005, a total of 1.9 to 2.2 million tons of electronic products were obsolete. 1.5 to 1.8 million tons of that total was disposed in landfills and less than 400,000 tons were recycled [11]. While this represents only the general waste dimension of the sustainability picture, leaving aside the energy consumption issues, we believe it makes clear the negative impact of the consumption and disposal cycle of digital artifacts.

Ecological design's focus has been on replacing toxic substances in materials with biodegradable or non-toxic substances, promoting energy efficient technologies, and encouraging recycling and safe disposal. For example, theoretical approaches such as Life Cycle Assessment (LCA) consider the environmental impact of materials, fabrication, use and disposal as a comprehensive measure of a product [14]. Most notably, ecological design has taken hold in architecture, urban planning, product design and automotive design [28], but not in interaction design.

Sustainability in interaction design is a relatively new concern [22]. Digital artifacts create unique issues with regard to materiality, and the role of users and use is paramount. Eli Blevis's paper, *Sustainable Interaction Design: Invention and Disposal, Renewal and Reuse* [5] is a critical introduction of sustainability issues to interaction design and HCI communities. Blevis advocates a critical design perspective or an ethical design stance in which interaction designers have a heightened awareness of the environmental impact of their design enterprise. For example, he establishes a critical link between the ongoing designs of new versions of the same software that "prompts physical qualities," thus driving the demand for new hardware that creates unsustainable disposal, as is the case with Apple's iPod [5].

Our contribution to sustainable interaction design is theoretical: it revises the concepts of *user* and *use* in ways that in turn support sustainability. The contribution is a

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result of bringing together the notion of everyday design with sustainability in design. Revisiting central tenets in HCI theory like *user* and *use* is a major undertaking, one that has been an ongoing discussion in HCI resulting in continual incremental change, yet it is clear to us that the issues of sustainability require paradigmatic change. Our study looks beyond professional designers to end-users who design and redesign artifacts by using them (even long after the artifacts have left the hands of professional designers). Our approach is in sympathy with socio-technical user studies that broadly speaking examines the social construction of technology, i.e. looking past the impacts of technology to the social shaping of it [3, 21, 24]. In particular, ideas like the domestication framework [19, 29] that focus on what users do with technologies in the home are directly relevant. However these studies focus on the social meaning of artifacts and the critical reading of design objects as texts. Our study and findings are more circumscribed by a focus on HCI theory and interaction design principles.

In our ethnographic study that is the basis for our theory, we found families to be creative and exploitive in their interaction with design artifacts. We found that people construct their home and home life by resourcefully appropriating existing designs, adapting them into new and unique systems, and allowing for the emergence of design qualities and functions over time. Inherent in these actions are the principles of invention, renewal, and reuse, which are principles at the heart of a sustainable practice. The implications of our findings are that the role of a creative agent in the life of artifacts is a sustainable identity for users that emphasizes principles of sustainability in interactions with design artifacts. This is in direct contrast with a consumer identity that engenders patterns of consumption and disposal. The motivation for this paper is to promote the creation of interaction design artifacts that can ultimately be creatively redesigned by everyday designers thus contributing to sustainable interaction design. We found that the actions of the *everyday designer* with today's non-digital artifacts strongly suggest new desirable attributes for tomorrow's digital artifacts.

The statistics of household waste and e-waste cited earlier are largely a result of reifying people as consumers. In practice, HCI's general understanding of the user is as a consumer. Functionality and needs are determined on a short-term basis, e.g. more consumption is triggered by frequent changes in the use requirements of a digital product that in turn accelerates or "refreshes" (creating incremental improvements that produce new hardware) the product's life cycle. Further, it is assumed that user needs can be modeled in sets of interrelated requirements aimed at formalizing activities. These requirements are fixed as a set of functions within a digital artifact. The problem is that if even a single need changes or a new need is discovered, the product becomes obsolete and new versions are created. This accelerates consumption in the name of better

understanding user needs. Ecological design aims to mitigate harm in the consumer model by addressing reductions in toxicity, energy consumption, and waste. However, the constant product releases and accelerated life cycles of digital products will overwhelm this approach. Within HCI and interaction design we need a critical reframing of theories of use in regard to sustainability that at least mitigate the negative effects of the consumer cycle if not move beyond it. While the average household in the "developed" world is viewed as wasteful, we found many patterns of interactions in our ethnographic work that conflict with this understanding and present signs of *resistance* to the notion of the consumer model of use. We believe that these actions that can be leveraged into the design of digital artifacts.

In this paper, we discuss the ideas of sustainability in design by looking at both ethical and environmental sustainability. We see a convergence between these schools of thought and a leveraging of earlier concerns in HCI regarding ethically sustainable systems. We then focus on our ethnographic studies of family use in the home. We discuss how patterns of *design-in-use* theorized in the context of *everyday design* describe a revised understanding of use and a sustainable identity for "end-users." We base our analysis of the ethnographic accounts on Blevis's Sustainable Interaction Design (SID) principles and rubric [5]. We conclude with a discussion of how *everyday design* contributes to the notion of a sustainable identity for users, new design-in-use principles, and implications for HCI and interaction design.

#### **SUSTAINABILITY IN HCI AND DESIGN**

Sustainability has taken on at least two meanings in the evolution of HCI and design: socio-technical and cooperative design methods that aim to establish ethically sustainable technical systems through the participatory involvement of end-users, and the more current environmental sustainability. We give some attention to HCI's past efforts in ethical sustainability since we believe this history and its impact on the changing and central role of users serves as a fulcrum of sorts for sustainable interaction design.

#### **Ethical Sustainability**

Based on ethnomethodological studies of interactions, Lucy Suchman's work focuses on the situated actions of people using designed systems; she argues for restating ideas of *production* and *use* such that a distinct boundary does not lie between them [31]. She suggests that instead of designing "discrete devices", we should aim at designing "working relations" which "sustain the visible and invisible work required to construct technical systems and put them to use" [31]. Suchman's characterization of good design includes sensitivity to local ecologies and work practices, building a whole picture of the users and the use situation, rather than being focused on specific tasks and technical requirements of the system.

Christopher Alexander [1] discusses what he terms the *unselfconscious process*: a design process undertaken on a cultural level and over a long period of time, where designed items are shaped gradually and continually to fit the surrounding, ever-changing context. Individuals participate in this process in an unselfconscious way, simply recognizing a failure in the system and reacting in a corrective way to achieve a well-fitting form. Alexander would eventually describe the process of continuous adaptation as *piecemeal building* [2].

Gerhard Fischer's meta-design evolves the idea of unselfconscious design by investigating open and closed systems and the role of end-user modifications [12]. Meta-design promotes sustainable co-designing by way of *seeding* and *evolutionary growth* that is incrementally refined by end-users like tending to a software system like a living entity [13].

More comprehensively, social-technical concerns in the UK and Scandinavia led to participatory design theories and methods that aimed to achieve political as well as technical sustainability of systems [10, 17]. This approach to systems design involves the anticipated users of the system in the ongoing design process, working alongside professional designers in order for mutual learning and exchange to occur. This design process emphasizes issues of democracy, social factors, and human activity within a situated work environment. Each of these perspectives on ethically sustainable system design provides evidence for thinking of users as co-participants in the design process, rather than simply benefactors of it.

#### Environmental sustainability

More familiar than the idea of ethical sustainability is the concept of environmental sustainability. Buckminster Fuller and Victor Papanek were two early advocates of ecologically sound, human centered design [16, 25, 26]. Each of them questioned the sustainable nature of modern human industry in terms of its effect on the natural environment, and investigated alternatives to ecologically damaging practices.

In more recent years, Tony Fry elaborated on the relationship between design and sustainability, introducing the idea of *defuturing*: self-destructive design that accelerates a negative outcome by destroying natural resources and establishing unsustainable systems of production and use [15]. Blevis brings the idea of sustainable design firmly into the domain of HCI by drawing on Fry's notion of *defuturing* to consider what kind of future might be brought about by the development of sustainable HCI methods [4, 5]. He highlights unsustainable practices within HCI, including material concerns such as the use of toxic metals in computers and other technologies, as well as market-driven obsolescence. Later in the paper, we will expand on Blevis's contributions and utilize his principles of Sustainable Interaction Design.

Stuart Walker's recent book *Sustainable by Design* [38]

also addresses issues of sustainability from an industrial and product design perspective. By his own account, the book is not empirical research but rather his own "phenomenological understanding" based on reflection and intuition. While on the surface Walker's work appears to coincide with our own, the focus as well as the conclusion reached is quite different. Walker's concern for users and their actions is a small part of his argument, and his goal instead is to create an "aesthetic taxonomy" that supports sustainability. Walker sees the current design industry as blocking people from themselves creating material meaning. We argue that people are already continually engaged in this process via acts of appropriation. More substantively, he argues an avant-garde role for designers in overhauling the production industry, a role that maintains the distinction between users and designers. We argue instead for a breakdown of this separation and a new identity for users that supports sustainability by leveraging existing design activities within the home.

#### THE HOME AND SUSTAINABLE DESIGN ACTIONS

The home is a critical site for HCI and interaction design. It represents a new application domain that has spawned many recent attempts to fit technologically sophisticated applications into the patterns of domestic life. The home has become a testing ground for new technology paradigms like ubiquitous computing and ambient intelligence that have spawned novel, if not altogether successful, applications. The home presents a different set of challenges than those found in the comparatively well-trodden ground of technology for the workplace. Perhaps most challenging from an HCI perspective is that the home represents an unprecedented diversity of users and discretionary use [18].

#### Everyday Design study

Recent studies of the home have focused on issues of communication among family members [9], domestic technologies [6], ubiquitous computing [34] and disciplinary concerns of methodology and accounts of the home [23, 33]. Our own *everyday design* research extends the previous studies by describing the process of adaptation in the creation of *everyday design* systems [35, 36], the roles of collaborative creative agents, and in this paper, its applicability to sustainability. We discuss families as a creative agent in an ongoing continuum of design that extends beyond the professional designer to *design-in-use* in the home. We describe home dwellers as a type of *everyday designer* who remakes or modifies systems and who appropriates design artifacts and surroundings as creative resources [36]. For example, we often appropriate designed artifacts and surroundings for new uses such as hanging a jacket on a chair or storing items on a ledge, stair or short wall. Such redesigns are typically expedient and temporary; however they can also be adapted to form the center of ongoing routines, and can be combined to create long-term systems. Short walls, furniture, and a stairwell surrounding a front door through which the mail is received can form a system for sorting mail. Stairs can be used to

sort laundry for different members of the household. The activities described are familiar to all of us and therefore may be overlooked. However, on close examination the actions represent unique design responses to particular settings.

Our study involved four families with young children ranging in age from 2-13 years old. The families included two married couples and two mothers with live-in partners. The study occurred over two five-month periods, and included over 460 hours of observations and interviews and a team of researchers including three ethnographers. The principal investigator (Wakkary) knew the families to varying degrees and lived in the same neighborhood. The study was designed in four consecutive phases: 1) developing a relationship with participants (shifting from observers to participants), 2) focused data collection of targeted routines and activities, 3) directed open-end interviews and video walkthroughs aimed at informants explaining their routines and systems, 4) follow-up and member check six months after the last ethnography session. Further details on our design ethnography methods can be found in [37].

### ANALYSIS

From our observations, we present three examples of *everyday design* that illustrate patterns of *design-in-use* that are sustainable actions. We analyze each example in relation to one or more of Blevis's SID principles.

#### Blevis's Rubric, Principles and Examples

In order to make sense of the ensuing analysis we provide an overview of Blevis's principles for SID [5]. The principles reference a rubric for forms of use, reuse, and disposal in relation to sustainable interaction design. These are *disposal*, *salvage*, *recycling*, *remanufacturing for reuse*, *reuse as is*, *achieving longevity of use*, *sharing for maximal use*, *achieving heirloom status*, *finding wholesome alternatives to use*, and *active repair of misuse*. Blevis states that the rubric is "useful for understanding the environmental impact of interaction design in terms of use of physical materials and resources, however prompted by the use of digital materials" [5].

The principles are divided into first and second order. First order principles are operative in all instances of SID and the two first order principles are in opposition i.e. *promoting renewal and reuse* is a mitigating principle for *linking invention and disposal*. First order principles include:

- Linking invention and disposal—is a principle that links invention as a cause of disposal;
- Promoting renewal and reuse—is a principle about the design requirement for sustainability which includes several of the rubric terms, namely salvage, recycling, remanufacturing for reuse, reuse as is, and sharing for maximal use.

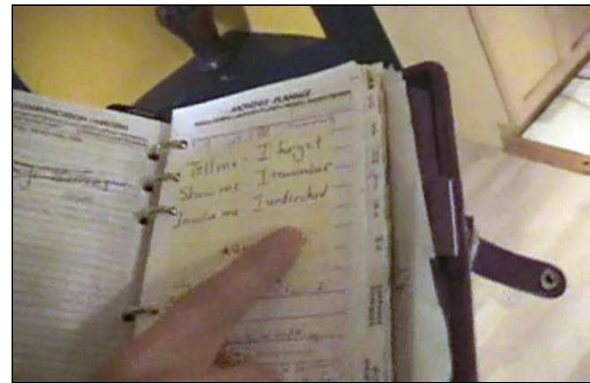


Figure 1 Lori shows how a sticky note allows reuse of a page of her planner

Each second order principle relates to ways to promote *renewal and reuse* over *invention and disposal*. Second order principles include:

- Promoting quality and equality—is a principle about the design requirement for sustainability concerning what is required to motivate *reuse as is*, *achieving longevity of use*, *sharing for maximal use*, and *achieving heirloom status*;
- De-coupling ownership and identity—is a broadly construed principle about fashion, the commons, security and privacy, and sense of selfhood in the context of globally changing conditions for the construction of identity as these motivate relationships to the materials of consumption, especially with respect to the possibilities for *sharing for maximal use*;
- Using natural models and reflection—promotes imitation of nature in the use of resources and processes. This theme is connected to *achieving longevity of use*, *sharing for maximal use*, *achieving heirloom status*, *finding wholesome alternatives to use*, and *active repair of misuse*.

#### Three Examples

The three examples we present each illustrate different SID principles. The first example addresses both first order principles. The remaining two address second order principles that promote *renewal and reuse* over *invention and disposal*. Examples of interactions with digital artifacts that exemplify SID and *everyday design* are virtually non-existent (the main reason for writing this paper), nevertheless we believe its a very productive starting point to apply SID principles to the use of non-digital artifacts and then leverage these observations to influence the design of digital and interactive technology artifacts.

#### Example 1. Planner Book: Promoting Renewal and Reuse; Linking Invention and Disposal

Lori is a part-time primary school teacher, who lives with her five-year-old son and during the time of our study, a live in partner named Abe. One session in which Lori was shopping we noted how she wrote messages and lists on

sticky notes and kept them in her handbag. This led to a discussion about her planner and how she uses it (see Figure 1):

Lori: My girlfriend gave me a planner and I thought 'oh great - it's one of those Filofax [brand name] things!' It's super-compartmentalized and organized, and I thought, 'this is great - I will have all my little sections, you know, [she flips through the planner] but I really never used the sections properly. And I ended up, you know, just finding my own...way...of storing information [she continues to flip through the book], which half of its...I used to buy the refills and I used to just have papers and write notes and rip them out and it became this sort of like 'oh here's a piece of paper, I'll write down a note, rip it out.' So it's empty now, it used to be full of paper - I just sort of kept the ones - there are some recipes, old phone number lists, and whatever.

Almost from the beginning Lori shifted the intended use of the planner. As she saw it, she "never used it properly," which did not stop her from using it and even ordering refill pages. In her hands, the planner had become a notepad of blank paper for use despite the printed templates for calendar entries and lists on the refill pages. It also became a place to keep notes whether loosely or bound in the book.

Lori: Then I started to get some sticky notes and so that would end up being stuck in [she motions to slap a sticky note to one of the page]....

The sticky notes allowed her to augment the planner. Notes could now be placed anywhere in the book, even over used pages. And notes could be taken on sticky notes and later stored in the planner if she did not have it with her at the time.

Lori: Like I have, you know, lists of - almost like a calendar but I didn't use the calendar actual...calendar...pages? I would just use them as lists of things that I needed to do for...coming...days. And then I sort of ended up adding, you know, notes to myself. It became just everything. I had like sayings [she shows a saying written on a sticky note stuck on a page] in there that I liked. I'd have teaching ideas that I'd get in other classrooms...dance steps... I don't know - it just had everything!

At this stage Lori's planner had become a place to keep notes and lists. She no longer used any of the originally designed structure of the planner, ignoring the categorized sections for notes and addresses, and the calendar section (the main design feature). She had even stopped ordering refill pages since sticky notes allowed her to reuse the already filled or ripped out pages. Lori used, revised and evolved her agenda book over several years.

Lori's agenda illustrates the two first order principles of *linking invention and disposal* and *promoting renewal and reuse*. These are opposing principles, however, we find in this example a case where invention is linked to reuse. The same central qualities of appropriation (changing the

intended use) and adaptation (revising and combining into a larger system of interactions) that are at the heart of *everyday design* form the basis for *renewal* and *reuse*. Rather than Lori adopting the specified use of the planner formalized in its design, she adapted the planner to her changing needs. She used the design attributes of the planner that best suited her as design resources: portability, durability of the cover, writing surface, refillable papers, removable papers; and ignored those attributes that did not serve her: tabbed categories, calendar pages, other printed templates. The adaptation of the planner was a *renewal*. The sticky notes and new invention for creating and maintaining lists and messages was here linked to *reuse*. Lori's planner includes several of the categories in Blevis's rubric related to the first order principles [5]: *salvage*, *recycling*, *remanufacturing for reuse*, and *reuse as is*.

Implications for interaction design include: 1) design the capacity for users to overlook the formalized design and still find the artifact usable in ways equal to or greater than the original design intentions for use; 2) incorporate materials and software qualities to allow for renewal and invention.

#### Example 2. Kerry's Recipe Book: Promoting Quality and Equality

Kerry is a dancer but spends the majority of her time managing the household and her sons aged two and seven. Her husband Beck is an electrician and a musician. Kerry likes to cook and has a reasonable collection of cookbooks. Active ones are kept near the stove and ones she rarely uses are stored in an upper shelf in a cabinet nearby. One session while she was preparing dinner she pulled out her own recipe book to look for a soup recipe. The book is distinctly different from the other cookbooks. It is a personal notebook with a floral pattern cover (see Figure 2). She described how she has used it for over ten years as a recipe book and before that it was her mother's journal. There are few journal entries if any in the book but it does hold loose recipes that Kerry's mother continues to send her. Near the beginning of the book are Kerry's dessert recipes, separated by several blank pages and in the middle of the book are



Figure 2 Kerry's recipe book was originally her mother's journal and has been in use for over a decade.

main courses, and at the back of the book, entered in reverse order, are the soup recipes.

In addition to the pages of written recipes, the book contained many newspaper clippings of mostly recipes, some unrelated lists such as the word “hello” translated into several different languages, and on one page she found a Christmas list she had written years ago. She said “this Christmas list is funny because it’s no different from the lists I make now.” She showed Beck and he wryly said “It’s true, I’ll just refer to that list from now on.”

Kerry’s recipe book illustrates the principle of *promoting quality and equality*. Even though the book is over ten years old it is continuing to evolve where in addition to keeping recipes, it is the place to keep personally valued lists and newspaper clippings. Typical of a family heirloom item, it runs no risk of being disposed of and so is a safe place to store things like a Christmas presents list. The recipe book holds all the SID rubric attributes related to this principle, including: 1) *reuse as is*, seen in Kerry appropriating her mother’s journal for a different purpose without modifying its physical properties; 2) *achieving longevity of use* as demonstrated by the recipe book being more than a decade old; 3) *sharing for maximal use* in that the book originally belonged to her mother; and 4) *achieving heirloom status*, where in many respects all the other qualities together that give the recipe book this vaulted status.

Implications for interaction design include: 1) consider collaboration to include the broader notion of sharing, e.g. conceive of a Personal Digital Assistant (PDA) designed for maximal use by a family and therefore is easily shared; 2) consider that longevity in interactive technology is not only a result of usefulness and that we design emotional qualities into artifacts.

### Example 3. Family Calendar: De-coupling Ownership and Identity

Ryan is a high school social sciences teacher. Janis is a legal aid worker. They have two sons; Timmie age eight and Andrew age ten, and a daughter Brenda, age thirteen. At the beginning of our study, Janis together with Timmie placed a calendar on the refrigerator door that they hoped the whole family would use in order to share information and coordinate appointments (see Figure 3). At the time only Ryan had a public calendar on the wall and that was exclusively for his appointments and scheduling of runs since he is an avid runner. The new calendar was initially only used by Janis and Timmie. Janis would coordinate the family appointments. She encouraged Timmie to participate by using stickers to mark holidays, birthdays and professional days (days off from school). Through the course of our study, Ryan eventually migrated to using the calendar (although he kept his “running calendar”) and it was evident that he eventually saw the real benefits of sharing a single calendar for the family.



Figure 3 Timmie placing a sticker on the family calendar

In a discussion with Ryan about the calendar he said that the fridge calendar is mostly for Janis and him to keep a record of what needs to be done. In addition, each day they discuss how to coordinate the day’s events. He pointed out that there are headers on the calendar listing household chores for the kids as well. Ryan finds it too hard to keep track of everything without having a central repository like this calendar: it keeps the “complex activity available to everyone.”

Janis is encouraged that her family is gradually using the family calendar more as time goes on. She attributes some of the success to replacing the initial calendar with a second larger calendar that has more presence on the fridge door. Timmie discusses the calendar with great enthusiasm and takes some pride in his involvement right from the start. Brenda likes the stickers for the calendar and she agrees that the larger calendar is a big improvement over the smaller one. She has her own agenda for school that she uses for her personal scheduling but doesn’t want to share it with the family. Janis also has her own agenda at work but she sees it as a real problem that she cannot simply “merge” it with the family calendar. As it is now, she has to make sure that work appointment gets transferred to the family calendar.

The principle of *de-coupling ownership and identity* may raise the most complex issues of all the principles. In support of sustainable actions, the example illustrates Janis’ persistence in *sharing for maximal use*. While the benefits of sharing are oriented in this case toward efficiencies in communication, it raises the many issues of privacy, identity, and public information even within the context of a family. As a teenage daughter Brenda is unequivocal of the need to have her own agenda that is private from the family. Janis has no qualms of sharing her information; in part she is so intertwined with the family activities that it is hard for her to know what is separately hers. For example, her work

schedule is flexible and dependent on family activities. Ryan sees no public value in his running information and sees the necessity of his own calendar as functional rather than a privacy issue.

The implications for interaction design evident in this example are shared with the previous example in respect to maximal sharing. Additionally, the example raises complexity that goes beyond efficiency and is nearly impossible to predict. Interactive technologies that allow for the kind of *ad hoc* and public testing and experimentation with low risk are desirable so that families can easily test combinations and solutions that will lead to more complex systems.

## DISCUSSION

### Comments on the SID Rubric and Principles

The preceding three examples utilize Blevis's SID rubric and principles to examine sustainable practices of *design-in-use*; however, it is important to note that our application of Blevis's ideas differ from his. In particular, when defining his "rubric of material effect", he almost exclusively refers to examples of physical artifact and materials such as upgrading computer processors and memory to run the Vista operating system or company practices of equipment exchange and disposal [5]. In contrast, we have applied these "material effect" concepts to both material and non-material aspects of people's interactions with artifacts – a result of focusing on use. For example, the wall calendar example is less concerned with the materiality of the objects in question than with the meaning the whole system has within the minds of the family members and within the larger organization scheme of their home. We believe that Blevis's concepts suit this wider interpretation and offer insight in areas outside of the material domain. Further, in the example of Lori's planner we found a link between *invention* and *reuse*, which appears to run contrary to the first order principles mutual exclusivity. Perhaps we are misunderstanding Blevis, however we believe there is a sustainable role for invention.

### Design-in-use Principles

The pressing question is how to shape the ethnographic accounts and the reflections from a SID perspective into a coherent approach in both practice and research. In many respects, it will take all current efforts combined to tackle the sustainability issues. We believe ecological design provides a well-established approach to understanding the mitigating factors in materials, production and energy use with regard to fabrication and disposal concerns. Blevis's SID provides a solid starting point for addressing concerns around the training and development of an ethical orientation of professional interaction designers. We offer another dimension for understanding end-users' existing everyday interaction practices with artifacts that can be leveraged into the design of digital artifacts.

We advocate that designers leave space for people to be actively creative in order to enable their use of digital

artifacts as design resources. In reconsidering the life cycle of artifacts, *design-in-use* is a critical factor. We advocate that designers, in addition to designing with SID principles to guide design practices, design with the end-users' *design-in-use* principles in order to understand the ongoing design life of design artifacts and the artifacts' potential sustainability. The principles include:

- ***Design-in-use* involves a high degree of creativity that in the best sense of the word makes a user unpredictable.** Often, HCI's approach to modeling the user is too brittle and over-determined; *design-in-use* requires an underdetermined approach to the user. This limited model of the user embraces the idea that we do not need to define use in predictive detail. In the examples in this paper the artifacts discussed were not designed with these new uses and redesigns in mind however through design decisions of material choices, flexible structures, support for sharing, and simplicity, a space was created for users to evolve new uses not conceived of by the designers. This acknowledges the role of another creative agent, the *everyday designer* who engages in *renewal and reuse* over consumption. The creativity of the user establishes the foundation (not the challenge) for a sustainable identity; unpredictability is reframed as a positive attribute of the user rather than an obstacle to "proper use".
- **Design artifacts become resources for further creativity as an outcome of *design-in-use*.** Artifacts will be used in ways beyond their designed use. Appropriation becomes a design goal in *design-in-use*. Again, this calls for a minimalist approach in considering the physical or virtual design outcome. The simplest of products that can easily be reused will do well. It asks that professional designers design artifacts so they are open to and even invite use in ways that were not intended in the original design. For example, in the digital artifact equivalent of paper, rather than consider it as a medium that supports written text and drawings, we can design toward an action space that invites rolling, folding, marking, ripping, making holes, gluing together, etc. The degree to which a designed artifact can be appropriated is directly linked to its degree of sustainability. Electronic products in particular require greater and simpler actionable attributes in order to be redesigned like the day calendar, rather than the current proliferation of highly targeted "features" designed to address pre-determined needs.
- ***Design-in-use* qualities emerge over time as do design actions.** Design artifacts exist in an evolutionary and complex environment. The value and use of artifacts changes over time as they are

combined with other artifacts into systems, renewed through discovery of new uses, or the situation or needs change. Rather than becoming obsolete, artifacts may be dormant for a period and then find a new role, as with Kerry's adoption of her mother's journal into a recipe book. Recognizing that qualities emerge over time requires us to consider more than just the explicit usefulness of an artifact that is to include more passive usefulness, emotional attachments, and other reasons for longevity. We might consider identifying states and transitions of artifacts in order to better understand this process and identify the true long-term value of artifacts.

These principles are additive to existing design approaches and not mutually exclusive with other strategies. It is not always appropriate to apply *design-in-use* principles. For example, if the goal is to manage email applications from home, traditional modeling of users makes greater sense than applying an *everyday design* framework. It should be noted that the overall notion of designing systems in use is not foreign to HCI. In the context of ethically sustainable systems, Austin Henderson and Morten Kyng [20] discussed "continuing design in use" in which they saw the need for "tailoring" of software systems for the changing needs of workers. It was not important who made the changes in the system, but it was important that the design and architecture of software allow for future modifications that would be discovered as necessary through use.

### A Sustainable Identity

Geoff Cooper and John Bowers in a pivotal essay on the rhetorical discourse of HCI, *Representing the User* [8], argue that the concept of the user was created as a new discursive object that was exclusively the concern of HCI. The notion of a user is a core concept in the claim that HCI is a legitimately distinct discipline from Human Factors. The user remains at the center of all discursive claims to HCI and it should come as no surprise that a sustainable notion of HCI involves a reformulation of the user. We claim that the *everyday designer* represents a sustainable identity for the user, one that is different than the traditional HCI construct. The differences include:

**From consumer to creator:** The *renewal and reuse* principle demonstrates the role of creativity over consumption in the identity of the *everyday designer*. In this role, "end-users" are creative co-agents who through *design-in-use* invent and renew designed artifacts. For example, for years some Mac users have been turning old all-in-one Macintoshes into aquariums, known as "MacQuariums," rather than disposing of them.

**From over-determined to underdetermined:** This creates space for users to "perform themselves through the use of the technology." As we've identified, these performed actions tend to be sustainable actions of renewal, reuse, and invention. For example, the *squillo* is a one-ring mobile phone call first widely used by Italian teenagers that

identifies the caller by caller-id. The unanswered (and free) call is simple yet contains multiple expressions from an affectionate hello, to a flirtation, to letting someone know that you are running late but on your way [27].

**From user to designer:** The sustainable identity relies on design actions that allow for the reshaping of the world around us. It rests on the ability to appropriate and adapt artifacts as design resources that lead to the promotion of *renewal and reuse*. For example, despite the marketing of inexpensive and disposable solutions by the furniture company IKEA, "IKEA hackers" have pushed beyond the do-it-yourself culture that the company invites in order to repurpose and renew IKEA items to adapt to their unique and changing needs. For example, MP3 files have made Compact Discs (CD) and in turn CD holders obsolete. In response, an IKEA hacker reinvented IKEA CD holders into a dish rack by combining two together.

In summary, the importance of this study is two-fold. It resulted in design principles that anticipate end-user or everyday design as part of a design-in-use lifecycle. These principles compliment SID design principles and promote sustainability through incorporating potential longevity, reinvention and reuse into the design of interaction design artifacts. Secondly, we propose an expansion of the concept of user in HCI theory to include a creative, underdetermined designer or an everyday designer as part of a sustainable identity for the user in HCI.

### CONCLUSION

We proposed a reframing of the user and use as one approach to sustainable interaction design. We claim that the lens of *everyday design* reveals that people often engage design artifacts through *design-in-use* in ways that lead to the sustainable actions of renewal, reuse and invention. This offers an alternative view of end-users that is resistant to the consumer cycle that is typical of digital artifacts. Further, past HCI and design research in ethically sustainable systems offers the advantage of considering sustainability through reformulating the concept and role of the user. We present *design-in-use* principles as a set of operational precepts for interaction designers and HCI researchers to understand how designed artifacts become recreated and redesigned. We conclude with a formulation of a sustainable identity based on *everyday design* and sustainable interaction design that shows shifts from a traditional HCI identity for the user to an alternate sustainable identity. Our aim with this paper is to show how existing interactions and relationships with non-digital artifacts point the way to a sustainable approach to interaction design that is informed by a new theoretical concept of use.

We plan in our future work to design artifacts that follow the design-in-use principles and assume the ongoing interactions and reinvention by sustainable everyday designers. However, this design research is not trivial since it is a new research and design program that will require



ongoing involvement and evolution over time. While theoretical contributions like in this paper may lack the definitiveness of an experimental study or the living proof of a designed system, we strongly feel it is a necessary and productive step to support our future work and to address the complexities of sustainable HCI.

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#### REFERENCES

- Alexander, C. *Notes on the Synthesis of Form*. Harvard University Press, Cambridge, 1964.
- Alexander, C., Ishikawa, S. and Silverstein, M. *A Pattern Language: Towns, Buildings, Construction*. Oxford University Press, New York, 1977.
- Bijker, W.E., Hughes, T.P. and Pinch, T.J. The social construction of technological systems: New directions in *The Sociology and History of Technology*. MIT Press, Cambridge, Mass., 1987.
- Blevis, E. Advancing sustainable interaction design: Two perspectives on material effects. *Design Philosophy Papers*, 4. 2006.
- Blevis, E., Sustainable interaction design: Invention and disposal, renewal and reuse. *In Proc. CHI 2007*, ACM Press (2007), 503-512.
- Blythe, M. and Monk, A., Notes towards an ethnography of domestic Technology. *In Proc. DIS 2002*, ACM Press (2002), 277-281.
- Electronic Takeback Coalition. Facts and figures on E-waste and recycling. [http://www.e-takeback.org/docs%20open/Toolkit\\_Legislators/tools/Facts%20and%20Figures%20on%20E%20Waste%20and%20Recycling.pdf](http://www.e-takeback.org/docs%20open/Toolkit_Legislators/tools/Facts%20and%20Figures%20on%20E%20Waste%20and%20Recycling.pdf), 2007. Last accessed Sept. 15, 2008.
- Cooper, G. and Bowers, J. Representing the user: Notes on the disciplinary rhetoric of human-computer interaction in *The Sociological and Interactional Dimensions of Human-Computer Interfaces*, Thomas, P. ed. Cambridge University Press, New York, 1995, 48-66.
- Crabtree, A. and Rodden, T. Domestic routines and design for the home. *Computer Supported Cooperative Work*, 13. 2004, 191-220.
- Ehn, P. *Work-oriented Design of Computer Artifacts*. Arbetslivscentrum, Stockholm, 1989.
- Environmental Protection Agency, United States Government. Fact sheet: Management of electronic waste in the United States EPA530-f-08-014, July 2008, 12 pages.
- Fischer, G., *Meta-Design: Design for Designers*. *In Proc. DIS 2000*, ACM Press (2000), 396-405.
- Fischer, G., Grudin, J., McCall, R., Ostwald, J., Redmiles, D., Reeves, B. and Shipman, F. Seeding, Evolutionary Growth and Reseeding: The Incremental Development of Collaborative Design Environments, in G. Olson, T.M., & J. Smith eds. *Coordination Theory and Collaboration Technology*, Lawrence Erlbaum Associates, Mahwah, New Jersey, 2001, 447-472.
- Frankl, P. and Rubik, F. *Life Cycle Assessment in Industry and Business: Adoption Patterns, Applications and Implications*. Springer, Berlin; New York, 2000.
- Fry, T. *A New Design Philosophy: An Introduction to Defuturing*. UNSW Press, Sydney, Australia, 1999.
- Fuller, R.B. and Loeb, A.L. *Synergetics; Explorations in the Geometry of Thinking*. Macmillan, New York, 1975.
- Greenbaum, J.M. and Kyng, M. *Design at Work: Cooperative Design of Computer Systems*. L. Erlbaum Associates, Hillsdale, N.J., 1991.
- Grudin, J. Three faces of human-computer interaction *IEEE Annals of the History of Computing*, 27 (4). 2005, 46-62.
- Haddon, L., Mante, E., Sapio, B., Kommonen, K.-H., Fortunati, L. and Kant, A. *Everyday Innovators: Researching the Role of Users in Shaping ICT's*. Springer, Dordrecht, the Netherlands, 2005.
- Henderson, A. and Kyng, M. There's no place like home: Continuing design in use, in Greenbaum, J. and Kyng, M. eds. *Design at Work: Cooperative Design of Computer Systems*, Lawrence Erlbaum Associates, Hillsdale, New Jersey, 1991, 219-240.
- Latour, B. *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard University Press, Cambridge, Mass., 1987.
- Mankoff, J.C., Blevis, E., Borning, A., Friedman, B., Fussell, S.R., Hasbrouck, J., Woodruff, A. and Sengers, P., Environmental sustainability and interaction. *In Ext. Abstracts CHI 2007*, ACM Press (2007), 2121-2124.
- O'Brien, J. and Rodden, T., Interactive systems in domestic environments. *In Proc. DIS 1997*, ACM Press (1997), 247-259.
- Oudshoorn, N., Pinch, T.J. *How Users Matter the Co-construction of Users and Technology*. MIT Press, Cambridge, 2005.
- Papanek, V.J. *Design for the Real World; Human Ecology and Social Change*. Pantheon Books, New York, 1972.
- Papanek, V.J. *The Green Imperative: Ecology and Ethics in Design and Architecture*. Thames and Hudson, New York, 1995.
- Rheingold, H. *Communication Through Rings*, July 27<sup>th</sup>, 2002.

- <http://www.smartmobs.com/2002/07/27/communication-through-rings/>. Last accessed Sept. 15, 2008.
28. Shu-Yang, F., Freedman, B. and Cote, R. Principles and practice of ecological design. *Environmental Reviews*, 12. 2004, 97–112.
29. Silverstone, R. and Haddon, L. Design and the domestication of information and communication technologies: Technical change and everyday life. In Silverstone, R. and Mansell, R. eds. *Communication by Design: The Politics of Information and Communication Technologies*, Oxford University Press, Oxford, 1996, 44-74.
30. Statistics Canada, Government of Canada. The daily: Human activity and the environment: Solid waste, December 2, 2005. <http://www.statcan.ca/Daily/English/051202/d051202b.htm>. Last accessed Sept. 15, 2008
31. Suchman, L.A. Working relations of technology production and use. *Computer Supported Cooperative Work*, 2. 1994, 21-39.
32. Sustainable Development Unit (SDU), Food and Rural Affairs (DEFRA), United Kingdom Government. Sustainable consumption and production - household waste, 2006.
33. Taylor, A.S. and Swan, L., Artful systems in the home. *In Proc. CHI 2005*, ACM Press (2005), 641-650.
34. Tolmie, P., Pycock, J., Diggins, T., MacLean, A. and Karsenty, A., Unremarkable computing. *In Proc. CHI 2002*, ACM Press (2002), 399-406.
35. Wakkary, R. and Maestri, L. Aspects of everyday design: Resourcefulness, adaptation, and emergence. *International Journal of Human-Computer Interaction*, 24 (5). 2008, 478-491.
36. Wakkary, R. and Maestri, L., The resourcefulness of everyday design. *In Proc. Creativity and Cognition 2007*, ACM Press (2007), 163-172.
37. Wakkary, R., Poon, M., Maestri, L., Kirton, T., Juhlin, C. and Betts, R., How informances can be used in design ethnography. *In Ext. Abstracts CHI 2007*, ACM Press (2007), 1875 - 1880.
38. Walker, S. Sustainable by Design: *Explorations in Theory and Practice*. Earthscan, Sterling, Va., 2006.