Sustainable Millennials: Attitudes towards Sustainability and the Material Effects of Interactive Technologies

ABSTRACT

This paper describes the design and interprets the results of a survey of 435 undergraduate students concerning the attitudes of this mainly millennial population towards sustainability *apropos* of the material effects of information technologies. This survey follows from earlier work on notions of Sustainable Interaction Design (SID)—that is the perspective that sustainability can and should be a central focus within HCI. In so doing it advances to some degree the empirical resources needed to scaffold an understanding of the theory and principles of SID. The interpretations offered yield key insights about understanding different notions of what it means to be successful in a material sense to this population and specific design principles for creating interactive designs differently such that more sustainable behaviors are palatable to individuals of varying attitudes.

Author Keywords

Sustainability, Sustainable Interaction Design, Design, HCI and design, Value Sensitive Design.

ACM Classification Keywords

H5.m. [Information interfaces and presentation (e.g., HCI)]: Miscellaneous. J.7. [Computers in other systems]: Consumer products. K.1. [The Computer Industry]: Markets. K.4.m. [Computers and society]: Miscellaneous.

INTRODUCTION

In this paper, we describe the design and interpret the results of a survey of 435 undergraduate students concerning the attitudes of this mainly millennial population towards sustainability *apropos* of the material effects of information technologies. Our survey follows from earlier work on notions of Sustainable Interaction Design (SID)—that is the perspective that sustainability can and should be a central focus within HCI. In so doing, we advance to some degree the empirical resources needed to scaffold an understanding of the theory and principles of SID. The interpretations offered yield key insights about understanding different notions of what it means to be successful in a material sense to this population and specific design principles for creating interactive designs differently such that more sustainable behaviors are palatable to individuals of varying attitudes.

The concept of sustainability refers to the *viability of our collective future* and includes issues of social equity, public health and wellness, and ecological stability. Its importance for design has already been widely embraced in other design fields. It is motivated by values-oriented notions of design by such authors as Friedman and others [10-13], Cross [8], Kling & Star [19], Nelson & Stolterman [32], Löwgren & Stolterman [21], Margolin [27-29], Nardi [30,31], Papanek [34], Schön [37], and Stegall [39]. It is motivated as well by designers' *in-practice* recognition of the agency of how designed things themselves shape *us* in complex ways, as much as we shape the world by means of our own designs—an agency which has been described by Winograd and Flores [45], Willis [44], Fry [14], Makelberge [24] and others inspired primarily by Heidegger [17].

The importance of considering sustainability within interaction design was argued by Blevis [3] at the 2007 CHI conference, where it was also taken up in a special interest group meeting organized by Mankoff and others [25]. The focus in SID to date has centered on the link between environmental sustainability and interactive technologies in two broad senses: (i) *sustainability through design*—how interactive systems can be used to promote more sustainable behaviors; and (ii) *sustainability in design*—how sustainability can be used as a critical lens in the design of interactive technologies themselves [25]. Sustainability and interaction design are addressed directly in Blevis and others [3-7], Friedman and others [10-13], McDonough & Braungart [23], Mankoff and others [25,26], Makelberge [24], Nardi and others [30,31], Stegall [39], Thackara [40] and this nascent literature is growing.

In the [withheld] Group at [withheld] University, our work has focused on the latter. As interaction designers, we have primary responsibility for the effects of the products we create. For example, according the United States government Environmental Protection Agency (EPA), *"Americans discard approximately 2 million tons of used electronics, including computers and televisions each year. In addition, an estimated 128 million cell phones are retired from use annually"* [43]. The toxicity of such a massive amount of electronic waste has dangerous environmental consequences. The acts of interaction designers are implicated in this situation, not only *apropos* of the design of hardware devices, but also as pertains to the design of software which may often be the cause of premature obsolescence of hardware.

One of the goals of SID is to mitigate these consequences through both *design criticism* and *critical design,* which are defined by Blevis [7] as *"design criticism—understanding the effects of present ways of being on future ways of being, and critical design—informing choices about potential future ways of being."*

To this end, [3] gives a rubric of possible material effects of particular interactive systems in terms of *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*. Also in [3], several design principles are proposed as hypotheses for how to achieve the more desirable effects of the rubric in place of the less desirable ones. The 5 principles are: (i) *linking invention and disposal* (ii) *promoting renewal and reuse* (iii) *promoting quality and equality* (iv) *decoupling ownership and identity* and (v) *using natural models and reflection.* As a design critical method, this framework can be utilized to critique particular interactive technology designs. In [4,5] this method is demonstrated with regards to cell phones, mp3 players, cameras, desktop software, and other technologies.

Research Questions

In the interest of critical design, strategies are needed that will allow interaction designers to achieve more sustainable forms of use. The following research questions, reproduced from [3], can be seen as the starting point of our inquiry:

(a) *"How can digital artifice be designed such that people will prefer sustainable behaviors to unsustainable ones?*
(b) *What would it take in the design of digital artifice—as opposed to dictates of public policy—to get people to prefer renewal & reuse to invention & disposal?*
(c) *Assuming that not everyone will be willing to give up the materialism that drives unsustainable behaviors, how can design influence more sustainable consumption and what are the tools that can allow designers to do so?"*

From a human-centered design perspective, finding such design strategies begins with a thorough understanding of people's relevant behaviors and attitudes. For example, people's attitudes towards sustainability, purchasing choices, disposal, and transfer of ownership are all important to consider before making design decisions. The following questions are more precisely formulated to elicit these issues:

(a) *To what extent do users prefer new as opposed to used digital artifacts, and how does this differ from other products?*
(b) *To what extent are users concerned about sustainability and how does this correlate to their consumption of digital artifice?*
(c) *What is the preferred replacement cycle for different interactive products?*
(d) *What is most commonly done with obsolete products, and what factors contribute to these choices?*

Research Approach

In an attempt to answer these questions, we conducted a survey of 435 undergraduate [withheld] University students. Most of the respondents were between the ages of 18 and 21, which locates them in the generation known as *Generation Y,* or the *Millennials*. This generation already outnumbers the baby boomers and will likely be the first 100-million-person generation according to Howe & Strauss [18]. Often referred to as the "Net Generation," several of their most defining characteristics stem from the fact that they have interacted with technology since birth. They demand constant connectivity, consistently use the internet as their primary source of information, have no tolerance for delays in technology services, are much more digitally literate than previous generations, and anxiously await and purchase the newest technology devices as described by such researchers as Oblinger & Oblinger [33], Frand [9], and Howe & Strauss [18]. Given these characteristics, this population has the potential to generate and do generate massive amounts of technology-related waste. However, this generation is also known for rejecting individualistic needs in favor of more community-based needs. They desire norms and rules, engage in more service oriented activities, and believe that one of their main goals, as a generation, is to improve the environment [18]. Thus, there is great potential in studying this group from the standpoint of sustainability, especially as it relates to technology.

In what follows, we describe related literature. We follow with a review of our survey methodology and results, most notably describing emergent attitudes and patterns. We then present qualitative interpretations of the survey results and the ensuing implications structured according to the rubric of material effects of interactive technologies. We also develop implications for design in the form of material attitude profiles based on our quantitative and qualitative analyses. Finally, we conclude by discussing the broader implications of our work for general notions of the confluence of sustainability and interactive technologies.

LITERATURE REVIEW

While it is widely known that our planet's resources are limited and that waste has become a pressing issue, it is less widely publicized that an increasing amount of today's waste is electronics related. The US EPA has recently focused on this issue, finding that *"electronics already make up approximately 1 percent of the municipal solid waste stream. Research completed in Europe shows that electronics waste is growing at three times the rate of other municipal waste"* [41]. What is of particular concern is the toxicity of electronics waste or *e-waste,* which contains lead, cadmium, mercury, and other poisonous chemicals. An additional growing concern is the sheer numbers of computers, cell phones, and other devices that are disposed annually. As far back as 1999, Tsuhan Seikatsu reported that over 70,000 used cell phones were discarded daily in Japan alone [in 47]. In 1997, a Carnegie Mellon study estimated that 55 million computers would already be in landfills by the end of 2005 [22]. In addition, another EPA report found that 75 percent of outdated electronic equipment was being stored rather than being thrown away or remanufactured [41]. When these items are ultimately disposed, their collective impact on the waste stream will be significant. There are many factors contributing to the e-waste stream. Three of the major issues are described immediately in what follows:

Interactive technologies have short product lifetimes and are perceived to quickly lose value

In a 2003 business press poll of how business professionals regard computer service lives, the notion that a 3 year old computer was too old and well past its useful service life prevailed [2]. To dispose of such easily obsoleted equipment, many companies try to sell or give it to employees or donate it to charities or schools. However, data security, ongoing support issues, and the overhead associated with managing such programs can be overbearing. Few of those polled understood that much of the equipment that is sent for recycling produces little positive effect.

Unfortunately, the short product life of electronics is rarely due to mechanical issues. Seikatsu's 1999 report stated that most cell phones "*are not discarded because of physical breakage, making them unable to function; users are merely 'done with them' and toss the appliances for new ones or a later model*" [47]. Wooley [46] has termed this phenomenon, "*choreographed obsolescence",* an intentional business strategy which "*ensures that the life of products is governed by their position within a company/sector innovation cycle, rather than resulting from the vagaries of product durability. In the computer industry for example, the disposal of hardware because it is at the end of its life, is rare and usually takes place because of superseding product and technological innovation at reduced cost.*"

The "technological innovation" implicated above can be that of hardware or software, as they are both "*connected to a cycle of mutual obsolescence*" [3]. As an example of how new software can induce the disposal of hardware, [7] describes the introduction of the Microsoft Vista operating system in 2007. This source quotes an Information Week article from 2006 [15] in which it is estimated that at the time of Vista's release, "*About half of business PCs are unable to run Microsoft's Windows Vista operating system because they don't have the basic system requirements."*

"Reuse" and "Recycling" are not always as beneficial as people intend

Shipping old electronics overseas so that parts can be harvested, equipment can be donated to needy organizations, or precious metals can be salvaged has become a common practice. Numerous problems complicate such forms of reuse and recycling. A key issue is that individuals are left feeling as though they have done something positive for the environment when the opposite is often the case. Such measures do keep some of the components out of landfills, especially the landfills found in developed countries. However, what happens to much of this e-waste is unknown. For the most part, the electronics industry remains unregulated. Stories of mountains of equipment filling swamp land, extensive burning of equipment as a disposal method, and terrible working conditions for workers attempting to remove the valuable metals from toxic portions of the hardware are frequent [36]. Even with the best remanufacturing and reuse intentions, much of the equipment sent to such sites is beyond salvage. According to one study "*Up to 75% of the electronics shipped to the Computer Village are irreparable junk, according to the Computer and Allied Product Dealers Association of Nigeria, a local industry group. Nigeria has a thriving repair market, but no capacity to safely deal with electronic waste, most of which winds up in landfills and informal dumps*" [36].

The process of recycling the materials of which many electronics are composed produces many known health hazards [36,38]. For example, the heating of plastics and heavy metals creates highly toxic fumes.

Finally, even when materials are safely recycled or prepared for reuse, there are often market issues with which to contend. It is often difficult for companies to find a market for the raw materials they have recycled or the usable components they have harvested from old equipment. For instance, with the advent of the LCD monitor, many parts from old CRT monitors are no longer marketable [20]. In addition, storing materials and components until they are needed is becoming a problem [16,20]. Even though the EPA advocates the reuse and recycling of components, they readily admit that we should "*be aware, however, that in many cases, the material value of retired electronic equipment does not cover the cost of* *dismantling or preparing the component materials for market*" [42].

Few plan for environmental impacts at the design phase

Until recently, the fact that most products have a lifecycle which ends in the "grave" (landfill) has been generally accepted. Now, different models are being proposed. One, called the "*cradle to cradle*" approach of McDonough & Braungart [23], advocates a zero waste system in which products are designed with their full lifecycle in mind, ensuring that all resources are re-usable. Many others in both scholarly and business press sources have come to the conclusion that this process starts with the design of the product itself [34, 27, 39 ,40].

In an often cited 1997 technical paper, Mathews and others [22] praised recycling and remanufacturing efforts for lowering the amount of e-waste. However, these authors were careful to note that such methods are not enough. The report states that "*the key to successfully improving environmental quality of any product is to make informed decisions at the design stage. Modular Design and Upgradeability is intended to alleviate some of the need to constantly upgrade equipment, and thus, to reduce potential waste*" [22]. The study also suggests component reuse, specifying the use of materials which are not toxic, and properly labeling parts for end-of-life decision making as major steps in the design phase. Finally, it promotes "*policy directions*" such as green marketing, supplier management, recycling promotion, and resource recovery and product take-back. Each of these suggestions is to be planned and implemented at the design phase. Other academic institutions have come to similar conclusions. In their study of the complexities of recycling, André & Cerdá [1] concluded "*the problem of waste management and recycling does not begin with the waste flow from consumption, but at a previous stage, when production decisions are made.*"

The US EPA is strongly urging that manufactures "*design for the environment*" (DfE) by using less toxic or even recycled materials and designing products which are easy to upgrade or recycle [42]. Other countries are enacting strict laws and regulations. The EU has several such regulations, one requiring manufacturers to take back and properly dispose of used electronic equipment, free of charge [16,38]. This strongly encourages electronics producers to consider waste management at the design phase of the product. Taiwan and Japan have similar regulations in place [16].

These facts point to a very real need for designers to become involved in the solution. Specifically, we need to find ways to extend the lifecycle of items, transform recycling and reuse to safe and less expensive processes, and ensure that companies begin the process of product development with sustainability in mind.

Even though there are many sources within academia, business, and government that advocate starting with the design phase, very little research on sustainable design is found to date in the HCI and interaction design literature other than what we have already referenced in this paper. Moreover, it is incumbent on interaction designers to consider not just the interactive devices themselves from the point of view of environmental effects, but also contexts of use and design for cultural change that can affect more sustainable human behaviors.

SURVEY METHOD

To better understand the possible implications of the rubric proposed in [3], a twenty nine question survey was prepared. In November of 2006, arts & science undergraduate students in an general education credit introduction to computing course at [withheld] University were asked to participate, resulting in the completion of 435 surveys using electronic collection (IRB #06-11332). The majority of participants were undergraduates between the ages of 18 and 21 and there were slightly more females than males. Initial results, in the form of percentages, were gathered and further data analysis using cross-tabulation in SPSS was used to reveal interesting trends. Correlations between variables were calculated using *Spearman's Rho*, the appropriate measure for crossing ordinal level variables. The resulting calculations show the magnitude as well as the direction of the relationship between two variables, followed by the level of significance (p) for each finding. In the results listed, a higher value of Rho indicates a stronger relationship between variables and a lower value of p indicates higher statistical significance.

SURVEY RESULTS

Some of the more interesting findings are presented below, organized according to attitudes and behaviors.

Attitudes

In general, this age group is not very worried about global warming, with 51% "somewhat" worried and 25.5% "not very much". The older the survey taker was, the more worried she or he was about global warming (Spearman's Rho=-.109, p=.025). Thus, we saw that the larger sample of younger respondents of our population were less worried than the smaller sample of older counterparts. Overall, only 18.8% were "extremely" or "very much worried."

It is also apparent that the group as a whole is not very clear on who is to blame for global warming, with the energy industry cited as the most responsible (3.88 average response on a scale of 1 to 5), followed by world governments (3.82), the automobile industry (3.79), the US government (3.74), and manufacturers (3.62). The lowest scores were attributed to individual consumers (3.37), product designers (3.3), hardware designers (2.77) and interaction and software designers (2.76). The lowest score of all was the category called "no one", which received a 1.46 on a scale of 1 to 5. So, it is clear that the vast majority of participants believe someone is responsible, they just aren't sure whom. While these students assess companies and governments as the most at fault, designers are still held to only a consequential amount of responsibility—although no less so than individual consumers.

Even among the most worried people, a high level of awareness did not translate into more sustainable purchasing practices, such as buying used instead of new items. Worried participants were not significantly more likely than their peers to buy used cars, laptops, Smartphones, or mp3 players (Spearman's Rho = -.029, p=.553; Rho =.055, p=.263; Rho=-.064, p=.190; and Rho = -.011, p=.815, respectively). Likewise, students' feelings of being worried did not correspond with disposing of old cell phones in more sustainable ways, such as donating them to recycling agencies (Spearman's Rho=-.027, p=.627). Here, we see that concern does not always result in a different attitude toward reusing these items.

Finally, although manufacturers rated 5th regarding responsibility for global warming, participants do see potential for manufacturers to play a part in curbing environmental impact. When asked if they would be more likely to buy a computer from a company that offered to take back and remanufacture their old computer as a matter of charity, 24% of the participants answered "yes" and 39% answered "probably yes." Moreover, 13% of people were even willing to pay for this remanufacture and 35% said they probably would, even if it did not benefit them directly. Additionally, there was no significant difference in participants' willingness to pay for remanufacture based on socio-economic status. According to our results, financial background does not significantly impact this sort of decision (Spearman's Rho=.043, p=.372), suggesting these choices may be more intrinsically motivated.

Behaviors

Behaviors divide into four categories, namely purchasing, replacement cycle, sharing, and handling end of service.

Purchasing.

There are many ways to purchase used technology (e.g. via websites, classifieds advertisements, from person to person, etc.). However, with so many options, we sought to investigate if this was a commonly accepted practice for this young population. While 71% of our participants prefer to purchase a used 3 year old car to a brand new car, only 28% said they would prefer a one year old laptop to a new one. These results suggest that participants tend to perceive primarily mechanical technologies, such as automobiles, bicycles, or home appliances, as more enduring than purely digital technologies. While this finding did was not surprising, interesting results surfaced on examination of smaller trends within the data. Among our survey takers, socio-economic status did not matter when deciding between new or used car, laptop, Smartphone, or mp3 player (Spearman's Rho=.021, p=.657; Rho=-.075, p=.121; Rho=-.041, p=.398; and Rho=-.002, p=.961, respectively). Survey questions were phrased in a way to ensure that participants knew that the used item was still highly valuable. Thus, it appears that people with more disposable income do not necessarily shun used items, as long as the item is perceived to retain its value.

In addition, participants indicating they would buy used laptops are also significantly more likely to buy used cars, mp3 players, and Smartphones (Spearman's Rho=.158, p=.001; Rho=.265, p=<.001; Rho=.303, p=<.001, respectively). These findings indicate that inclination to use previously owned technologies among participants requires a deeper examination than surface level socio-economic rankings. Saving money may be a significant motivating factor to purchase used items, however it is not the only one. Other possibilities include getting more value for the same amount of money, trying to be more environmentally conscious with purchases, or even as part of a general affinity for older, enduring things.

Replacement cycle

Replacement cycle refers to the amount of time an item is used by a single owner. Ideally, technology would be used as long as it is still functional. Nonetheless, the survey data suggests that many technologies are replaced much more frequently than is functionally necessary. For instance, the largest percentage of our respondents (32.8%) had owned 4-8 cell phones in their lifetime. This displays an extraordinary level of relative consumption, considering the average age of survey participants was 19.7 years. Participants with wealthier backgrounds had even higher purchasing patterns in product areas such as watches and cell phones (Spearman's Rho=-.164, p=.001 and Rho=-.249, p=<.000). However, being from a wealthy family did not make a significant difference in how often a person felt she or he should replace a car, laptop, mp3 player, camera, house, shoes, or clothes (Spearman's Rho=-.085, p=.080; Rho=-.038, p=.434; Rho=-.020, p=.686; Rho=-.052, p=.287; Rho=-.026, p=.593; Rho=-.021, p=.665; Rho=-.012, p=.802, respectively). The only item that participants from wealthier backgrounds claim to change more often is the cell phone (Spearman's Rho=-.116, p=.018). From these findings a theme emerged that suggests there is some sort of standard replacement cycle that people across socio-economic backgrounds follow on most items. However, based on our survey data, the cell phone consistently appeared to have a much shorter and unpredictable replacement cycle. This finding caused us to closely examine the nature of the cell phone and, in particular, its possible increased role as a status symbol in relation to other interactive technologies. In fact, across all respondents, the preferred replacement cycle for cell phones was closer to that of fashion accessories such as shoes and watches. A finding that contract models may be the most influential factor in cell phone replacement for some other populations may be reported elsewhere in these proceedings in [withheld].

Sharing

Sharing of interactive technologies, and the services they provide, represents a key sustainable practice that possibly makes the most of limited resources. While sharing a single cell phone among multiple people may be uncommon to citizens of the Western world, it is a widely adopted practice in many countries existing outside of the Western marketplace [5,30,35]. Among our survey takers, more than 50% were never willing to share laptops or cell phone accounts. Participants were slightly more open to the idea of sharing a desktop computer or software, with 48% and 38% reporting that they would be willing to share in some circumstances. A key theme emerged suggesting participants are less likely to share physical artifacts. However, when it comes to digital artifacts, such as music, games, and movies, most people preferred to share in most circumstances. We believe the reason that participants are more likely to share digital artifice in the conception of this group is because these things can be used by many people at once, almost limitlessly.

Of course, there were exceptions to these attitudes towards sharing. For instance, people who claim to be more worried about global warming are slightly more likely to share their laptops (Spearman's Rho=-.099, p=.044). But, this trend does not extend to all hardware. Once again, the cell phone is in a category by itself, with even the most environmentally minded no more likely to share them for our population (Spearman's Rho=-.018, p=.716).

One question on the survey asked if a person would be willing to help pay for the remanufacture of old equipment, even if it did not benefit her or him directly. In this case, a correlation arose among respondents who were more willing to pay for remanufacture and those exhibiting openness to many types of sharing behavior. This group is significantly more willing to share laptops, desktops, software, digital music, and digital games (Spearman's Rho = -.119, p=.014: Rho=-.130, p=.008; Rho=-.160, p=.001; Rho=-.104, p=.033; Rho=-.110, p=.023, respectively). These participants' willingness to pay for remanufacture may be seen as an attempt to share with those less economically capable of a new technology purchase. Cell phones were once again an exception. Regardless of the "sharing trend" mentioned above, this group was not more likely to share a cell phone (Spearman's Rho=-.015, p=.752).

Handling End of Service

When something is no longer useful to its owner, it may be disposed into the trash, sold or *free-cycled,* donated, given to a recycling facility, salvaged for parts, or preserved for possible future use, or stored without any reasonable expectation of future use.

Unfortunately, end of service choices that keep an item in use were not a common response in our survey. 52.8% of participants indicated they simply store old cell phones away. The other two most common categories were giving the phone to a recycling agency and giving the phone away to an individual for reuse. In our survey's open ended comments section, many respondents reported that they gave the phone to family members or emergency agencies, such as the fire department or abuse centers. A small number of participants reported they use old phones as alarm clocks or as toys for their younger family members. Finally, many participants claimed to have returned their old phone to their service provider to upgrade to a newer model. However, there is no way to know whether these phones were remanufactured and sold, given to a new group of users, or simply destroyed.

Regardless, even when consumers claim that they are willing to pay for the remanufacture of their old equipment, this does not necessarily translate into better end of service choices on their part. This group of people did not have significantly different disposal patterns for electronic items such as cell phones, even though they clearly believe that this sort of program is beneficial enough to support financially (Spearman's Rho=.014, p=.803). They still stored them away almost twice as often as all of the other end of service choices combined. This indicates that even with a high level of internal motivation, follow-through is low. Not having an obvious way to do something positive with old items, many people hold on to them. Either there is a belief that the item still has value or there is knowledge that disposal is damaging to the environment. Less than 6% of people threw away their old phones.

There are both encouraging and less than encouraging findings in our study. Overall, trends suggest that the undergraduates we surveyed are only somewhat worried about global warming, prone to massive consumption, and prefer to purchase new rather than used electronic devices. On a positive note, participants are more likely to purchase a used car than a new one and to give an old cell phone to a recycling agency than dispose of the cell phone as well as more willing to purchase computers from a company that has promised to take back and refurbish old computers than from one that makes no such promises.

QUALITATIVE INTERPRETATIONS

This survey builds on the rubric proposed by Blevis [3] to gauge undergraduate attitudes toward the material effects of interactive technologies. Although the survey results are relevant to all 10 items on the rubric, they presented distinct implications for six particular items:

Disposal. Most people are actually unwilling to throw electronics directly in the trash. Regardless of whether this is motivated out of desire to reclaim value, or a concern for environmental effects, it suggests that more sustainable user behaviors are achievable. Unfortunately, many items are people who like new things, especially latest technology

people who are apathetic about sustainability (care more about other things) | people who are concerned about sustainability

Individual Material Success Profile Strategy: 1. Try to get this group to buy things that are more useful to others later and prompt them to reuse by making it easy for them to redeem the residual value in the thing they would otherwise have discarded 2. Show that sustainable behaviors can be good business	**Collective Material Success Profile** Strategy: 1. Design things which preserve material as much as possible 2. Make it fashionable to buy new green things 3. Make it fashionable to think of "new to me" as just as new as new for things of sufficient quality
Legacy Material Success Profile Strategy: 1. Build sustainable features into quality things 2. Promote means of renewal and maintenance	**Global Collective Fate Profile** Strategy: 1. Make this group fashionable 2. Make them a target market for manufacturers (i.e. modular laptops) 3. Do research to allow informed decisions (Even when you're sincere, it's hard to know what to do)

people who like quality, enduring things – reuse, value, care and maintenance, value to others

Figure 1. personal profiles of attitudes and behaviors with respect to sustainable use of interactive technologies

simply stored away at end of service. As they continue to lose value over time, the opportunity for reuse declines.

More research needs to be done to determine why people chose to store products as opposed to other end of service choices. Perhaps if options for redistribution were made more accessible, the storing of still-functioning products would not be as common. In any case, this behavior represents an opportunity for SID practice to target more environmentally sound use of resources.

Remanufacturing for reuse. Survey results suggest participants liked this idea—some of whom displayed willingness to financially support it. However, it is also clear that, while this principle is valued, many do not act on it. If manufacturers were involved in the process, it might be more widely adopted.

Reuse as is. It is common for automobiles to be fluidly passed from person to person without losing significant value or functionality. Conversely, expensive technologies such as laptops and smartphones are not often purchased used. Evidence suggests that this trend could change if technologies retain their value as they are transferred from owner to owner and the standard lifecycle is extended through better design practices. As an example of such design practices, Asus has developed and promised to introduce upgradeable laptops into the marketplace. Dell claims that it will do the same. These are promising trends.

Achieving longevity of use. Survey findings suggest there is a standard cycle with most digital artifice that even socio-economic status does not affect (cell phones excluded). However, a correlation emerged among participants who are worried about global warming and a longer life cycle of use for digital devices, suggesting increased environmental awareness may play a part in achieving longevity of use.

Sharing for maximal use. Sharing is a complicated area, particularly in the case of cell phones. Evidence from our survey indicates respondents may be willing to share digital artifacts rather than physical ones. Cultural and societal differences may pose significant obstacles to implementing successful service-based sharing models within western marketplaces compared to non-western countries where infrastructure is less established.

Achieving heirloom status. Survey participants consistently indicated that electronic devices are not items they would consider passing down to their children. Our results suggest that the accelerated rate of obsolescence of digital devices makes achieving heirloom status for such devices difficult.

IMPLICATIONS FOR DESIGN

From the survey, attitude and behavior surfaced as two significant dimensions on which we based our evaluation. The attitude of the survey participants ranged from indifference to environmental issues to genuine concern. The behaviors of the survey participants ranged from people who prefer to buy new things to people who care about enduring things. Combining these two dimensions of attitudes and behaviors yields four quadrants which represent different profiles that may be used to characterize an individual's particular way of being in particular contexts.

These profiles are *individual material success*, *collective material success, legacy material success*, and *global collective fate*:

(a) By *individual material success,* we mean to include people who like new things and for whom sustainability in environmental terms is not a primary concern—such people may be inclined to acquire the latest interactive devices and may see such behavior as a necessary entitlement of success in a market economy.

(b) By *legacy material success,* we mean to include people who care to preserve durable things and pass them down from one generation to another and for whom sustainability in environmental terms is not a primary concern—such people care about the usefulness of interactive devices beyond the use of the first purchaser, leading to somewhat sustainable behaviors even if that is not the primary intention.

(c) By *collective material success,* we mean to include people who like new things and who care about sustainability in environmental terms—such people will care about the environmental credentials of particular interactive products they buy as well as how others will perceive their behaviors.

(d) By *global collective fate*, we mean people who care to preserve durable things and who care about sustainability in environmental terms—such people may alter their lifestyles to integrate environmentally conscious behaviors for the benefit of a global cause. This last group is an ideal to which a significant number of people aspire. Nonetheless, this group is unlikely to become large enough to offset the harmful effects of unsustainable consumption by itself and designers need to address all four profiles in their designs of interactive products.

All of this is illustrated in Figure 1 together with strategies for how to design for interactive products for each profile from the perspective of sustainability.

These profiles are characteristic and stereotypical—any individual can fit one or another of these profiles in different life contexts. It is important to note that these profiles are not intended to be used to label or judge whole individuals and each survey participant might fit one profile with respect to certain responses and another profile with respect to certain other responses.

Beyond the survey, there are undoubtedly people who fit say the *global collective fate* profile with respect to transportation or food, but who fit the *individual material success profile* with respect to wanting to own the latest interactive technology devices. Fostering awareness that sustainability issues relate to interactive technologies as much as to travel, food, home energy and other more visible aspects of environmentally sustainable behavior is a key design goal—the need for which is supported by our research.

Our survey population of primarily18-21 year old college students falls predominantly within two distinct categories. The largest group of participants is described by attitudes and behaviors characteristic of the *individual material success* profile. This does not come as a surprise considering their age, high level of disposable income, and strong familiarity with technology. Only 18.8% of survey participants specified they were very or extremely worried about global warming, characterizing the majority as more apathetic than concerned within our framework.

On the behavior dimension, numerous indicators implied that an item's newness was preferred over quality, value, or durability. Regarding interactive technology, 72% of respondents preferred a new laptop over a one year old laptop, even when substantial savings would be involved. On average, most of our population reported that they had owned 4-8 cell phones and that the typical choice for end of service of cell phones was personal storage. Extraordinary consumption, a strong desire to have the newest items, and tendencies to store away rather than look for means of renewal or reuse of interactive technologies characterize the *individual material success* profile.

While such findings are less than promising for sustainable behavior, there are some promising results. The majority of the millennial population we surveyed largely exhibit the qualities of the *individual material success* profile. However, a counter-culture exists within this population that fits within the *global collective fate* profile. Participants who claimed to be more worried about global warming are much more likely to engage in behaviors that help extend the life of interactive technology products. They were also much more willing to pay for the remanufacture of their old hardware, with no promised rewards to themselves. In addition, the participants who were willing to purchase used laptops were also much more willing to buy other used items such as mp3 players and smartphones. Qualities distinguishing the *global collective fate* profile include preferring longevity of use and value over newness, engaging in communal behaviors such as sharing and support for remanufacture to ensure future use by others, and a strong concern over environmental issues.

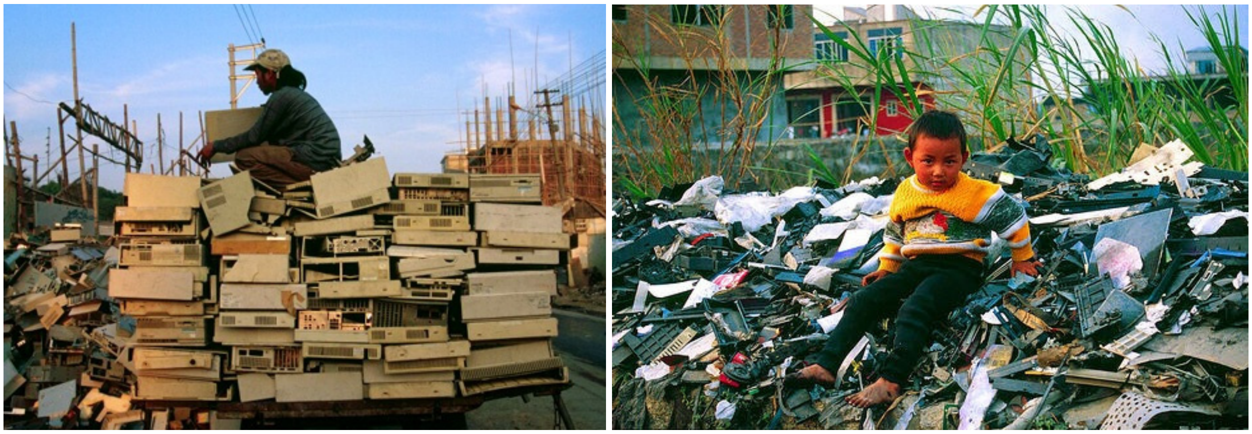

Figure 2. Images of unsustainable material effects of interactive technology use.

Images accessed from www.flickr.com/photo_zoom.gne?id=37078981/ and www.flickr.com/photos/phauly/37082413/ under creative commons license on 7.19.07

While there are findings that did suggest that some attitudes and behaviors fell within other quadrants, *individual material success* and *global collective fate* exemplified the staunch attitude and behavioral divide within our sample population. This is significant because it provides the HCI and Design community with a basis for conceptualizing distinctions among this population and draws attention toward two categories that, if addressed properly, could result in positive impact.

As important as the profiles which best characterize the survey are, the other two profiles—namely *legacy material success* and *collective material success*—are important in their conspicuous absence of representation in the survey data. As this population ages, starts families, and takes on working responsibilities, we expect that these profiles will apply as well.

The table of Figure 1 shows different design strategies that may be used to improve sustainability attitudes and behaviors depending on how a particular design context fits one of the four profiles. This table is a recipe for designing sustainably, in context. The strategies shown in the table are just a starting point for the strategies which may be imagined and inspired by future survey research and more general research in SID. Figure 2 serves as a reminder of how important such work is to our collective condition.

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[withheld]

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Contribution & Benefits Statement

Presents and interprets a survey of attitudes towards sustainable use of interactive technologies and presents implications of the results for interaction design.