

Using Design Critique as Research to Link Sustainability and Interactive Technologies

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Abstract. This paper echoes and points to work we have presented elsewhere on establishing the links between issues of sustainability and interaction design. The significant contribution of this paper is a description of the use of design critique as a research method and an argument for its importance to HCI researchers, especially with respect to very complex design contexts—the link between sustainability issues and interaction design research and practice, in particular.

Keywords: Design critique, design research, sustainable interaction design, research methods, design ethics and values, value sensitive design, social context of interaction design.

1 Introduction

In other work, we have argued that sustainability can and should be a central focus of the research and practice of design with the materials of interactive technologies [2,3], a perspective that has been echoed and articulated in several other sources we enumerate below. In this paper we first explain what we mean by sustainability and re-iterate a rubric and a framework we have developed for understanding how sustainability can be considered as a factor in design with the materials of interactive technologies. As a unique contribution of this particular paper and presentation, we argue that an important way of understanding the relationship between sustainability and interactive technologies is the method of *design critique*. It has been argued by some in the HCI literature and frequently in the design literature that design critique has not been generally understood as a method for research within HCI [37]. As a complement to other methods familiar in HCI—such as methods borrowed from ethnography, prototyping methods, field work and observations, case studies, surveys, interviews, and so forth—design critique is an important addition that allows interaction designers to achieve a nuance in their design research that can only be achieved by understanding *particular* designs and environments in very specific terms as opposed to *general* ones. This approach is common in design disciplines, and has been characterized by Nelson and Stolterman as the *designerly* notion that design understanding concerns the “ultimate particular” [23].

When it comes to issues of sustainability, the design issues under consideration are particularly complex and demand a nuanced approach. For example, the interrelationships between such issues as software, hardware, fashion, form, content, marketing, and copyright that affect our understanding of the Apple iPod as an example of a particular interactive device create a complex morass of effects, many of which have implications for sustainable and unsustainable behaviors. Before such issues can be understood in precise, measurable ways, we must first enumerate all of the factors and environmental contexts that play a role and doing so demands informal, phenomenological techniques like design critique to begin such a discourse.

Significance: The links between sustainability and interactive technologies are not often cited and yet, the consumption of computing technologies driven by the cycle of mutual obsolescence in which hardware and software are the key actors has great importance for the future of our collective human environments and conditions. There have been hundreds of millions of computers purchased new in the world in the last 5 years—with nearly a third purchased in the United States [2]. If advancing economies like China and India adopt western habits of consumption, the electronic trash generated by such practices predict potentially disastrous effects on the global environment.

Relevance: From the perspective of sustainability and interaction technologies, we repeat a rubric and framework for assessing the sustainable and unsustainable factors of particular interactive devices. The rubric relates to possible material effects that may result from the use and marketing of interactive devices, such as disposal, reuse, remanufacturing, sharing for maximal use, and other possibilities. The framework relates to design principles for promoting sustainable interactive design such as linking invention to disposal, or promoting renewal and reuse. In this paper and in referenced sources, we hope that this rubric and framework are sufficiently articulated that others in HCI will be able to apply them and understand them as a theoretical model and structure for evaluation. The notion of design critique is also situated within more familiar theoretical frameworks in HCI. The notion of design critique as research has been argued in the general literature, and this literature is referenced and situated in relation to the theoretical literature in HCI.

2 Design Critique

In a well-known article, Daniel Fallman [8] distinguishes between *design-oriented research*—research targeted at building design knowledge, and *research-oriented design*—design as an activity which makes use of tools of research. Our notion of design critique applies to both cases—that is, design critique is a way of creating design knowledge and design critique is also a tool in the practice of design. Without question, design critique is at least tacitly within the repertoire of tools used within the practice of interaction design. Understanding design critique as a foundational tool for developing design knowledge is much less well accepted within the scholarly literature on HCI. We argue that design critique deserves recognition within the HCI community and moreover, that it is oftentimes at least as appropriate as empirical methods in many and certain interaction design contexts where the complexity of effects is larger than what can be isolated as variables for experimental methods.

Definition. We define *design critique* as a process of discourse on many levels of the nature and effects of an ultimate particular design. Design critique may be regarded to be a research method and the act of design criticism can make use of intellectual and conceptual frameworks as a supporting mechanism of structure. Nonetheless, it is possibly an act without controversy to claim that design critique is better understood as part of a reflective practice of design than as science [6,23,30].

Design critique involves looking at an ultimate particular example in a non-reductive immediate way. The focus of a design critique in the context of interactivity can range from a particular model of cell-phone to a particular system of services that scaffold an interactive device to an understanding of the cultural and environmental effects that accrue from a particular co-mingling of hardware and software. The role of the design critic is to comment on the qualities of an ultimate particular from an holistic perspective, including reason, ethics, and aesthetics as well as minute details of form and external effects on culture.

The emphasis in the definition above on the notion of ultimate particular designs as being a designerly way of understanding owes to [23] and the notion of designerly ways of knowing is characterized more generally in [6], as well as Fallman [8]. The notion of the value of design critique as a method in-and-of its own right will have been introduced by Zimmerman, Forlizzi, & Evenson [37] with some anticipated controversy at this year's ACM CHI conference by the time this present paper appears. There are a number of attributes of design critique that make it important for consideration as a distinguished technique within the HCI community that is concerned with design, specifically

- (i) design critique accommodates the need to understand the effects and context of any particular interaction design on a number of different levels denoting a number of different contexts—for example, the level and context of individual use, the level and context of how interaction design mediates between individuals, the level and context of how some interaction design may create advantages for some groups while preserving or adding to the disadvantages of others, and so forth,
- (ii) design critique provides a mechanism for nuanced discourse and understanding of particular interaction designs, especially when to do otherwise would lead to overly reductive discourse and understandings,
- (iii) design critique can be fast compared to empirical studies; moreover, design critique can make use of secondary sources, especially compiling the insights that emerge from secondary readings of empirical studies into complex and nuanced wholes,
- (iv) further to point (i) above, design critique accommodates and fosters discourse at individual, communal, and societal levels about the nature and effects of particular interaction designs,
- (v) design critique accommodates and invites contrast and comparison between particular interaction designs and historically significant exemplars—contrasts and comparisons which yield an historically informed and predictive view not easily managed by empirical studies alone,
- (vi) design critique accommodates and provides a mechanism for comparisons that are massively multi-dimensional and cross-contextual, including

- contexts of interaction design that are formed from characterizations of fashion, form, color, appearance, operation semantics, function, and other dimensions,
- (vii) design critique accommodates and provides a mechanism for the consideration of ethics, aesthetics, and reasoning with respect to understanding interaction design
 - (viii) the integration of design critique as part of a designerly reflective practice—the term reflective practice owes to [Sch] and is echoed throughout the design and education literatures—is key to providing the designerly experience and judgment that can allow interaction designers to more effectively create meaningful and ethically-sensitive designs.

Comparison to other methods: There are of course many ways to inform interaction design in the context of complex conditions and levels of concern. Our claims above concern the reasons why design critique should be counted among such means, and specifically not that design critique is the only method that interaction designers should employ. An inventory of general design methods from the critical view of design in the context of information technologies is presented in [16]. A related discussion of the role of ethnography as a means of building knowledge in-and-of itself and achieving nuanced discourse is presented in [7].

3 Sustainable Interaction Design

One of the central notions of Sustainable Interaction Design (SID) is that the durability of interactive devices and the ability to reconstitute interactive devices with minimal or no waste in the presence of changing needs and requirements and in the presence of technological advances is part of the design of an interactive device. In other words, SID prescribes an ethical imperative to create things that last, that can be maintained, and that can be adapted as an aesthetic preference to things that are easily obsoleted and frequently disposed. As an ethical design principle within SID, we could say:

Make nothing that is disposable and make everything of such high quality that each thing endures and continues to delight and invites maintenance and renewal even as it passes from one person or context of use to another.

Reflections on an aesthetic of high quality durable things: First, this notion of an aesthetic of high quality durable things is not the only constituent notion of the idea of SID. Sustainability can be broadly construed to apply to the ongoing conservation and preservation of resources and well-being in terms of the environment, public health, global economic conditions, and many other aspects of the human condition and the condition of the earth.

Second, this notion of an aesthetic of high quality durable things stands in direct opposition to some enterprise models which require a constant cycle of obsolescence and acquisition for their own survival, irrespective of the survivability of those who may be effected including those who are the apparent primary beneficiaries of the profit motives which such enterprises serve. There are enterprises which create high quality enduring and renewable products. There are businesses that do both well and

good [32]. Sadly, few if any such enterprises within the marketplace for interaction design seem to be actively looking for opportunities to escape the enterprise model of what we have elsewhere termed “invention and disposal” [2,3].

Third, conservation and preservation of things is not always the best thing to do from the perspective of sustainability—at least theoretically. Sometimes new things are more resource efficient than old things to the point where it makes more sense from a conservation point of view to retire the old and use the new. This circumstance is almost never entirely clearly the case. The most obvious example is automobile technology, where one can reasonably consider if the environmental cost of manufacturing and using a new hybrid electric vehicle over its potential lifespan is less than the cost of adapting an older vehicle to new, cleaner or otherwise alternative fuel technologies such as propane, hydrogen, or bio-fuels. The answer to this question is not at all clear one way or the other. In the case of interactive devices design with the materials of information technologies, the question is also difficult to answer in any particular case. The US Environmental Protection Agency (EPA) offers a program to certify certain computer hardware as “Energy Star” compliant. According to the EPA site (www.energystar.gov), the criteria for this certification include: *“If left inactive, ENERGY STAR qualified computers enter a low-power mode and use 15 watts or less. New chip technologies make power management features more reliable, dependable, and user-friendly than even just a few years ago. Spending a large portion of time in low-power mode not only saves energy, but helps equipment run cooler and last longer. Businesses that use ENERGY STAR enabled office equipment may realize additional savings on air conditioning and maintenance. Over its lifetime, ENERGY STAR qualified equipment in a single home office (e.g., computer, monitor, printer, and fax) can save enough electricity to light an entire home for more than 4 years.”*

Especially with respect to the forth statement above, the question of if it is better from an environmental sustainability point of view to replace a computer which is not Energy Star compliant with one that is depends on if the energy savings more than offset the environmental cost of manufacture of the new device and disposal of the old one. This question is still not easy to answer and only underscores the complexity of understanding the environmental impacts of interactive design decisions. Moreover, if new chip technologies and software with better power management features are available for new computers, such technologies and software could cause enormous good if they become popular as consumer-installed upgrades that enable the preservation of old ones. Such good can only come from alternative models of enterprise to the present ones adopted by computer manufacturers.

This notion of an aesthetic of high quality things turns out to be a complex design context, as one begins to think about it deeply from a design point of view, especially from the point of view of design with the materials of information technologies.

A rubric and some principles: In [2], we give a rubric of material effects that can be used to understand by interaction designers as a kind of checklist to analyze and predict the environmental effects of particular interaction designs as a means of sorting through such complexities. The items of the rubric 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*. This rubric of material effects is further refined and developed in [3]. Also in [2], we give five principles that are intended as hypotheses about how

interaction designers can consider promoting less harmful material effects over more harmful ones. In [3], these principles are elaborated to include meanings of *critical design*—essential acts of design and *design criticism*—the analysis of design. The principles are *linking invention & disposal*, *promoting renewal & reuse*, *promoting quality & equality*, and *de-coupling ownership & identity*.

Additional sources: There are many other sources which relate to the notion of SID. The rubric and principles above are inspired by notions of sustainability and design described in [13,34,35]. A Special Interest Group meeting on the subject will have occurred at the 2007 ACM CHI conference [17]. In what follows, we discuss the case of cell phones, a case which has been investigated from the perspective of sustainability in [4,22]. The issue of sustainability in connection with ubiquitous computing has been articulated in [5,14,19,36]. The connection of sustainability to value sensitive design has been noted in [9] and value sensitive design in general is described in [9-12]. Designing interactivity to promote sustainable behaviors is described specifically in [18,33]. The use of design critique within HCI is in some sense pioneered by Norman in [24-27]. Sustainability and design are connected in [21,28,29,31,32].

4 Linking Sustainability and Interaction Design by Means of Design Critique

In [3], we give many examples of design criticism applications of the rubric described in section 3. We conclude this essay by sketching how the rubric and principles can be used in a critical design sense to generate considerations and concepts for how cell phones as an example may be designed as interactive devices in accordance with notions of SID.

Some background: In [22], the social implications of cell phone use and disposal are considered from the point of view of environmental sustainability. The authors point out the duality of utility and harm that arise from the design conceptualization of cell phones as disposable objects: “*Disposable cell phones combine utility and toxicity in one indivisible package. It is likely that the environmental hazard from these phones will be significant because they have a large potential market, promising immense usefulness and usability to currently underserved customers.*”

In a survey we ourselves conducted of 435 undergraduates students (IUB IRB #06-11332) in October 2006, we asked about the number of cell phones owned by the participants in their lifetime. Most of the participants were in their late teens or early twenties. The responses were extraordinary: “more than 15”=0.9% N=4; “9-15”=3.9% N=17; “4-8”=32.8% N=142; “3”=30.5% N=132; “2”=23.6% N=102; “1”=7.9% N=34; “0”=0.5% N=2; “No response” N=2. The survey responses suggest that cell phones, disposable by design or not, are effectively disposable in practice. Other survey results showed that the participants for the most part expressed a preference to change cell phones once a year or more (66%, N=428) if money were not an object. As a conjecture, the desire to stay fashionable is possibly the motivation for such rapid replacement, rather than technical utility.

Linking invention & disposal: Cell phones are interactive devices that form part of systems of communications which can vary widely from one context to another. In some markets, such as China, cell phones are not commonly provided by the service carriers, but purchased from independent vendors. In the US market, cell phones are provided by service carriers with the effect that switching carriers requires switching cell phones. The differences in features of one service provider's plans over another's in the US enterprise model co-mingle with the features of the actual hardware itself. Clearly, the Chinese model may promote less premature disposal of cell phones. The invention of new cell phones which integrate wireless internet and other features not yet common is a more troubling predictor of the early demise and disposal of many existing cell phones.

Promoting renewal & reuse: The separation of service providers from hardware vendors is just one way to promote less disposal. Separating aspects of a system promotes the kind of modularity that allows for renewal and reuse as an alternative to invention and disposal. Products like smart phones do exactly the opposite—integrating functions of various products into a single product predicts the early demise of that product as soon as any one of the integrated elements becomes obsolete. Smart phones that embed user-upgradeable operating systems and software in a manner that is backwards-compatible with the hardware remain an elusive promise. A better design for cell phones from the perspective of SID might involve separating at least the case, display, keypad, software, and internal electronic components into modules which may be replaced independently.

Promoting quality & equality: The separation of a cell phone into independently renewable components would allow for some of the high-touch components to be made of enduring materials that create the sense of quality for owners and the desire to maintain and renew rather than dispose and acquire. The cases on such a cell phone may be made of metals or other high quality materials rather than inexpensive plastics, since that portion of the product may be expected to endure. People who have invested in a cell phone case with the quality of an object of high fashion such as many kinds of watches or items of jewellery may be more inclined to update the internal components rather than discard the whole appliance. Furthermore, the value of the cell phone in promoting equality of experience may be better preserved by such design as ownership transfers. Similarly the internal components may be built to higher standards with more resistance to shock or moisture in order to promote longevity of use.

De-coupling ownership & identity: With things that have high fashion, the uniqueness and exclusivity and enduring qualities of an object matters. Items of apparel and jewellery in all manner of global cultural contexts can convey much about personal identity. See [20] for a wonderful photographic treatment of this phenomenon. With the things that emphasize only high status, having the latest invention or style may matter more than enduring qualities. Again, the separation of a cell phone into independently renewable components may allow for the endurance and uniqueness of the visible components themselves to convey sense of identity, rather than the need to convey sense of status that accrues from having the very latest thing. The uniqueness and exclusivity that creates cell phone fashion may primarily be about high status—the newest design is sold at a premium price that only the rich can afford and the rest covet until the price drops when a still newer design arrives. In other contexts

(clothing, music) fashion is driven by personal style, participation in subculture, and so forth. In addition to high quality enduring materials, perhaps the fashion of new technology can be replaced by the fashion of new original *digital content*. One example where this already occurs is ring-tones, where personal identity is expressed by having the latest most original ring-tone. See [15] for example.

Using natural models & reflection: In [1], the notion of *structure-preserving transformations* as a design principle is defined as the goal to make the built environment operate more like nature in which things evolve over time and the materials of old structures are preserved as part of the birth and growth of new ones. It is hard to imagine a cell phone achieving heirloom status, but perhaps some of its visible components can—especially the ones with which people interact directly.

Summary: An interactive device like a cell phone underscores the need for interaction designers to think beyond the scope of mere human-computer interaction. Cell phones incorporate interactive software, hardware, and services. Cell phones vary widely by context of use from one country to another, from one demographic group to another. Cell phones can be fashion and status statements. Cell phones can be made to be modular and selectively upgradeable if the enterprise models and will are present to do so. Interaction designers need to take all of these and other factors into account in the design of such devices. Such complexity demands that interaction designers engage in design critique of what is at present in order to inform the critical design of what is possible.

5 Conclusions

In this paper we have presented the fundamental idea that sustainability is an increasingly important concern with respect to the design of interactive products. We have argued that the complexity of this concern demands the use of design critique and that design critique needs at its foundation to (i) emphasize the ultimate particular, and (ii) be centered in a well developed intellectual and conceptual framework.

Our belief in design critique stems from an understanding that design is always about the ultimate particular. In designed products, all design considerations at all levels must be explained together as a single whole account. We also believe that such a whole account cannot be understood by an approach that is based only on reductive analytical thinking. Issues concerning sustainability cannot be reduced to individual measurable properties of a design. Instead, sustainability is always about the whole, and about how all possible aspects are composed into one. Design critique, as we have defined it here, has the potential to address the question of the whole. It is a process that is massively parallel through the appreciation of all qualities as a whole. Such an approach requires a developed sense of quality, as well as a sensibility of the particular. Experience and insights based on an abstract conceptual understanding must be coupled to a pragmatic and intimate relation to actual real designs.

Design critique is a way to foster such a sensibility of the particular over time within the mind of a designer. It requires an ongoing exposition of ultimate particular designs, and a constant struggle with trying to critique each particular design, not as an example but as a real design, as a whole. The reflection between an intellectual

abstraction—here the rubric and the framework presented—and the particular designs fosters an understanding both of the particular designs but also of the intellectual abstraction.

In order to link the design of interactive technologies with a sustainability issues, we propose that the field of interaction design has to develop both intellectual abstractions (such as the rubric and principles) that are not only theoretical constructs but are suitable as supporting frameworks for pragmatic design critique. In this paper we have described such a supporting framework that we believe would be suitable in relation to sustainability. We also propose that there is a need to develop the notion and understanding of design critique, not only as a process to gain insight of a particular design, but also as a way to develop insights that can further push intellectual foundations. In this paper we have presented a first characterization of the design critique process, as a necessary step in linking sustainability and interaction design.

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