A Proposed Framework for Assessing Environmental Sustainability in the HCI Community

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ABSTRACT
We propose a framework for assessing the sustainability of interactive technologies. Our goal is to initiate steps towards a common standard of measurement for sustainability in the HCI community. This could help motivate green competition, raise consumer awareness, and acknowledge environmental leadership. In this paper we summarize our methodology, our results, and discuss how the framework can be integrated for testing within the HCI community.

INTRODUCTION
Disciplines outside of HCI have provided guidelines for sustainable design [1][3], including design of products that promote a zero waste system such as the "cradle to cradle" design approach [8] and buildings [4][13]. HCI is a discipline that has traditionally focused on other values such as productivity and customer satisfaction. Some have argued that traditional HCI sustains an "ethos of constant consumption" [10].

An alternative is to identify the human factors that affect acquisition, disposal, renewal, and re-use and design for sustainability. Recent work by Blevis and others has begun to identify approaches to designing for sustainability (*e.g.,* [2][11]). For example, Blevis provides a rubric that can help designers understand the material effects of technology, along with guiding principles for sustainable design [2].

We argue that the ability to *assess* the sustainability of technology is a crucial next step. Assessment of sustainability can provide consumers with a way to compare different products, similar to the Energy Star criteria for appliances or the Leadership in Energy & Environmental Design (LEED) criteria for architecture [13]. Assessment criteria also set the standard for technology producers by providing a concrete, well-defined design goal. Once we have a common standard of measurement within our community, we can begin to motivate green competition, raise consumer awareness, and acknowledge environmental leadership within our community.

To initiate our contribution, we propose:

1. A framework, consisting of criteria to be used as guidelines for creating and developing sustainable technology.

2. A set of measurements that can enable technology to be assessed quantitatively.

The proposed framework is not meant to replace existing strategies that address environmental issues in design but to build upon those strategies so that we can begin measuring these criteria and holding each other accountable for developing sustainable technology.

METHOD
To achieve our goals, we held four semi-structured expert interviews lasting 45-60 minutes each. Our experts were selected from the areas of sustainable design, interaction design, architecture, and environmental and civil engineering. Two experts were LEED Accredited Professionals and three were university professors. We also considered related literature [2][7][11][13][14].

We coded extensive notes for a set of common themes, which were used to derive the contents of our assessment framework. For brevity, we discuss only some of the interview results here. Following that, we present our framework.

RESULTS
Our interview results were nicely synergistic with topics that have been suggested in past work, such as Blevis' rubric for sustainable design [2]. For example, one interview participant commented that while some devices, such as electricity monitors provide feedback, many fail to support reflection (e.g., how much does a specific device consume after 10 days?). She suggested the need for a "magic meter" that speaks to us in a language that makes sense and that allows us to reflect. What if a device was able to display not only how much energy it was consuming but what this meant from an environmental perspective, and what impact it has on future generations? Based on the related literature we had considered ([2][6][7][11][13][14]), we expected to hear about sustainability in terms of the durability and biodegradability of materials, alternative energy, and impact to future generations.

In our interviews, everything in that list was mentioned. Additional issues that were raised included: the provision of feedback to display a device's impact and/or effect its use has on the environment over time and a way for manufacturers to be held accountable for the end use of their products.

ASSESSMENT FRAMEWORK

An assessment framework can be prescriptive (meaning that the presence of prescribed elements are used to evaluate something) or performance based (meaning that outcomes such as energy use are measured to evaluate something). An evaluator (the person testing something against a framework) typically calculates a score for the thing being tested (be it a building, device, *etc.*). To do this, the evaluator will typically test for several outcomes or rules, assigning either a discrete or continuous value to the device for each test. Often these are further grouped into categories to provide a summary measure of the device's sustainability. For example, LEED currently has seven categories: sustainable sites and water efficiency are two of the seven categories [13]. LEED is a performance based rating system. Buildings adhering to these standards receive points and are acknowledged for meeting a certain number of criteria.

For the sake of simplicity, our framework is solely prescriptive. We took into consideration that performance-based methods require testing to ensure consistency in scoring. To keep things simple, each criteria is scored as "Yes", "No", or "Needs Info". If a device meets a certain criteria, an evaluator or consumer of the criteria would simply place a check in the appropriate category, if the device does not meet the criteria, consumers would select "No" and if there was not enough information to determine if a criterion is met, then the consumer simply selects "Not enough information" (see Table 1). This approach was selected because it is simple to apply and easy to update with new criteria. Although the system is highly qualitative, we believe that our framework provides a first step to raising key issues that consumers might wish to consider in evaluating the sustainability of a potential product. We include notations about whether a specific criterion was drawn from the literature, our interviews, or both.

Devices that consume less or use alternative energy

One participant described her electric tea kettle, "[it] consumes less energy…you put the right amount of water in" so there's not as much water wasted, it has a "more efficient heating element" and is simply an "infinitely superior design" as opposed to using the oven to boil water for tea. Another participant asked how we could reap the benefits of our natural environment?

- Uses alternative energy (i.e., powered by the wind, the sun kinetic energy, *etc*...) ([6], interviews)
- Lower energy consumption in comparison to similar devices (interviews)

Informative devices that speak to the user

One interview participant stated that there is a need for "features to support green environments" so people can *feel* their products are sustainable.

- Device is able to demonstrate the impact/effects its use has on the environment (positive or negative) (interviews)
- Device touts its sustainable features and/or "greenness" ([14], interviews)
- Device is made from durable materials ([11,13], interviews) (minimum of 10 years)
- Device provides feedback regarding its lifetime ([7], interviews)
- Device provides feedback regarding the state of its lifetime (interviews)

Devices that encourage sustainable behaviors

The following questions were raised from at least half of our participants: How can we effectively provide continuous and ongoing feedback for existing products, or those that are being developed? How can the products we develop, or modify encourage sustainable behaviors? How can existing products be modified so they encourage sustainable behaviors?

- Encourages sustainable behaviors as a result of its use ([11, 15], interviews)

The next set of criteria was fairly common and straightforward so for brevity, we exclude interview results.

Device has identifiable, fixable, modular components

- All materials are identifiable ([8,13], interviews)
- Device is modular and can be taken apart easily ([2, 7], interviews)
- All materials can be replaced ([2,13], interviews)
- All materials are reusable ([8,13], interviews)
- All materials can be recycled ([2,8,13], interviews)

Manufacturer supports "Take it Back!"

- Device can be sent back to the manufacturer ([12], interviews)
- Device is recyclable ([8, 12], interviews)

Loyalty

Another participant pointed out that no matter how knowledgeable one is regarding positive sustainability practices, it is difficult to compete against customer loyalty: "I just hope [Steve] Job gets it", he said:

- Promotes loyalty (strength of brand and their beliefs, reputation for quality products) ([2], interviews)
- Aesthetically pleasing ([2,7,11], interviews)

CONCLUSIONS

Our framework serves as a starting point for HCI to integrate into its community and to be improved upon until the community is ready to accept a standard for sustainability. Since this is a first step, it is important for us to try to adapt the framework into our practices and begin to identify what is both effective and ineffective. One way to adapt the framework is to do so at each stage of the product development or redevelopment lifecycle and to promote products that meet many of these criteria. Some questions to consider are:

- What is missing from the framework?
- What trade-offs are involved in the design of these rating systems?

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Table 1: Criteria for Assessing Sustainability

Categories	Criteria	Yes	No	Need Info
Devices that consume less or use alternative energy				
	Uses Alternative Energy (powered by: wind powered, kinetic energy, etc…)			
	Lower energy consumption in comparison to similar devices			
Informative devices that speak to the user				
	Device is able to demonstrate the impact/effects its use has on the environment (positive and/or negative)			
	Device touts its sustainable features and/or "greenness"			
	Device is made from durable materials (minimum of 10 years)			
	All materials are reusable			
	Device provides feedback regarding its lifetime			
	Device provides feedback regarding the state of its lifetime			
Devices that encourage sustainable behaviors				
	Encourages sustainable behaviors as a result of its use			
Device has identifiable, fixable, modular components				
	All materials are identifiable			
	Device is modular and can be taken apart easily			
	All materials can be replaced			
	All materials are reusable			
	All materials can be recycled			
Manufacturer supports "Take it Back!"				
	Device can be sent back to the manufacturer			
	Device is recyclable			
Loyalty	Promotes loyalty (strength of brand and their beliefs, reputation for quality products) ([2], interviews)			
	Aesthetically pleasing ([2,7,11], interviews)			