Accounting for Potentially Detrimental Unintended Impacts in HCI

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ABSTRACT
This position paper introduces sustainability as a natural human ideal of achieving equilibrium in light of the awareness of human contribution to global change. It discusses how humanity's contributions typically occur as unintended impacts from the design of products and infrastructures. ICT enables humans to better situate and manage information pertaining to our complex societies therefore being a powerful tool when addressing global change-related issues. This paper introduces a design process catered to the HCI discipline and purposed to minimize unintended detrimental impacts of the field.

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Sustainability, global change, unintended impacts, design, HCI.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

WHAT IS SUSTAINABILITY?

Sustainability is a naturally conceived concept in response to the rapid degradation of favorable environmental and socio-economical conditions. The degradation of these conditions is often the result of unintended impacts of human behavior, including the design of products and infrastructure for human use or support.

Global change is the collective occurrence of phenomena that effect the earth's and human civilization's functions on a global scale. These phenomena include climate change, critical resource depletion, sea-level rise, species extinction, etc. From the awareness of humans as contributors to global change was born the concept that humans should live with in the earth's functions and not only from them. To live within the earth's functions humans must be actors in the regeneration and renewal of ecosystem services.

Ecosystem services are "the benefits people obtain from ecosystem" [9]. The production of goods for use by humans such as food, fiber, medicinal compounds, etc. is only one form of ecosystem service. Ecosystems regulate the occurrence of natural phenomena such as floods and diseases. Ecosystems also support the formation of healthy soil, beneficial to the production of more goods. Of course, ecosystems support cultural activities spanning from recreational to spiritual, and everything in between.

Our ecosystems are becoming less and less capable of providing us with these services. Diseases that were once regulated by winter temperature and seasonal disappearance of required inputs now also have winter months to propagate. Flood and droughts are happening with greater frequency. Agricultural plants are becoming less productive, some becoming difficult to grow due to disease and changes in climate. Environmental sustainability is a foundational requirement for ongoing human survival.

WHAT DO WE KNOW ABOUT HOW SUSTAINABILITY MIGHT BE ACHIEVED?

To achieve environmental sustainability, the concept of living within the earth's functions must propagate through out human socio-economic infrastructures. Our agricultural infrastructure needs to replenish the nutrients in the soil in lieu of cutting down more forest when the land becomes inert. We need to focus on utilizing the natural occurrence of food, water, and energy within a local region instead of transporting them to other regions of the world.

We need to distill these sustainable and local qualities in our socio-economic infrastructures so that when a disaster occurs in a different region we are prepared to help instead of also being in distress. And what if the disasters happen to our sustainable and local society? The occurrences of disasters are less frequent and severe in the socio-economic infrastructures designed to support environmental sustainability. Thus the socio-economic infrastructures have opportunity for resilience and adaptability because they were *designed* to withstand the characteristic occurrence of natural disasters.

Many of the issues we currently face are resulting from unintended impacts of the design of our socio-economic infrastructures and consumer goods. These are all problems

of design. John Chris Jones said in his book *Design Methods*:

> *Perhaps the most obvious sign that we need better methods of designing and planning is the existence, in industrial countries, of massive unsolved problems that have been created by the use of man-made things, e.g. traffic congestion, parking problems, road accidents, airport congestion, airport noise, urban decay and chronic shortages of such services as medical treatment, mass education and crime detection.* [7]

We know that identifying, addressing, and finding alternatives for product design and infrastructure organization that leads to detrimental impacts is a must. We presently approach this course of action as mitigation of global change effects. Reuse, recycling, and composting of post-consumer goods is a form of mitigating the spread of toxic waste and disease as well as spoiling the beauty and purity of the natural environment. Requiring lower carbon-emissions from cars is a form of mitigating health concerns and global warming effects. While these mitigation efforts are in good intention to reduce the rate of global change, re-bound effects (e.g., driving more because cars emit less carbon) occur rendering many efforts ineffective.

WHAT CRUCIAL QUESTIONS REMAIN?

Disciplines that include sustainability as a goal or a condition for design are also subject to unintended impacts. These unintended impacts come to light because "traditional methods cannot adequately assess long-term visions as uncertainties and contradictions are too great, and therefore the predictability of risks is unreliable" [3]. *In general, design has the unique ability to contribute to or mitigate global change*. How can the process of designing for sustainability minimize the occurrence of detrimental unintended impacts?

HOW CAN HCI HELP ACHIEVE SUSTAINABILITY?

Unintended impacts may lead to positive outcomes. However, those that lead potentially detrimental outcomes must be identified and accounted for in the design process. HCI has great potential to influence transformation of design practices to ones that identify and account for unintended impacts. The inclusion of users in HCI research provides opportunity to initiate critical conversation around what unintentional impacts may occur. To help achieve sustainability, I propose that the HCI community should engage in the following process.

Design From a Systems and Environment Perspective

Sometimes the inclusion of technology is assumed in the design of systems, but the reality may be that (advanced) technologies are not the right solution [1]. In response to the technology-driven design of computer systems, the HCI field re-oriented the design process with users and humans as the focal point, and has become also become a misleading default assumption [10]. Designers of ICTs that do not see the product of their design as a component of a system are certain to overlook potential unintended impacts, including those that would rule out the need for ICT.

Victor Margolin suggests that an equilibrium world model should be taken on when designing for sustainability. The default world model in product and system design is typically the expansion model, which oriented around economic growth. In contrast to the expansion model, the world in the equilibrium model is a "system of ecological checks and balances which consist of finite resources" [8]. If a component of the system is over utilized, damaged, or extinct, the system will be knocked out of kilter requiring adaptation into a new semi-stable state. If enough components are damaged or removed, the system becomes susceptible to collapse.

Instead of designing to advance, the equilibrium model supports designing for robustness. Designers of ICTs for sustainability must become intimately aware of the system to identify the role the ICT will play. The ICT will effect and change the system in a variety of ways, and sometimes it becomes clear that the ICT cannot have an overall effective role in the system. However, in some cases of designing the ICT, the system or infrastructure maybe concurrently created.

Integrate Stakeholders as Active Members in the Design Process

Because social, environmental, personal, and economic implications of ICTs for Sustainability are of concern, various stakeholders in the design process must be integrated. The purpose of an Integrated Design process is to facilitate discussion across the various knowledge domains to bring to light the nature of and perceptions of complex issues that need to be addressed throughout the design process. Including stakeholders and consultants could minimize the number of unintended detrimental social, environmental, personal, and economic impacts the deployment of the ICT will have on those stakeholders.

Construct a public collective effort to address the effects of global change

Many people in the world do not have existing methods for addressing the global change effects they feel. As researchers, we need to develop solutions that both mitigate global change and enable adaptation to global change outcomes [6]. This may be done by both top-down and bottom-up approaches. In both cases, we want to provide humanity with survival tools in the event that societal and environmental collapses occur.

A public is a group of people addressing a common problem, or the indirect effects of a common problem, in the same manner [4]. Following Dewey's theory on multiple publics, many publics are addressing the effects of global change they feel themselves. Multiple publics that address a common problem use different methods based on

location, culture, understanding of the problem, nature of the indirect effects, etc.

If sustainability is a goal of the ICT we're developing and the design is taking place from systems perspective, the collective group of stakeholders should together engage in the construction of their own public. This means we need to engage with not only users, but with any person with interest or concern in the ICT and its encompassing system.

To construct this public, the stakeholders, including the orchestrating designers, would engage in a series of tactics that would facilitate the formation of their own behavioral strategies to address problems. The frequent alternative to this method is for institutions to prescribe behavior [5]. The first tactic they would engage in is the projection of potential scenarios that would lead to collapse of their community. Then they would engage in tracing of critical artifacts in the system (e.g., food if the problem is related to food security) to identify the networks in which they travel through, points of weakness, and needs for reinforcement. From these exercises the critical goal is to identify social, environmental, personal, and economic implications of both the existing manner in which critical resources are distributed and that of future scenarios. These identified implications should inform the need for and design of the new system infrastructure and supporting ICT.

Identify Marginals and Bring them to Focus

Overlooked areas of collective Stakeholder bias, misunderstandings, and unknowns of the design problem are opportunities for design to lead to unintended detrimental impacts. To identify these marginals stakeholders would engage in a reflection exercises [11]. For example, in designing an ICT to support a local food distribution system, residents would reflect on the food purchasing, preparation, and eating choices they make. These reflections would inform ways the ICT could encourage the same reflection process of its users. The designer would reflect on the limitations of the anticipated technology and the field as a whole, informing what values and experience the ICT could offer and if necessary. Together, the entire group would reflect on how the food distribution system and ICT could become the final authority of what they eat, how they eat it, and how the food is acquired. Points of marginalization or unconscious of bias would emerge from these reflections and should be brought toward the focus of the design.

Account for Risks in a Precautionary Manner

Once points of marginalization, or risks, are identified, they need to be evaluated so they can be accommodated for. Typical methods of evaluation of recognized risks are particularly insufficient when designing for sustainability because of the increased complexity, thus lessened tractability, of sustainability problems. The main reason for this is "that traditional methods cannot adequately assess long-term visions as uncertainties and contradictions are far too great, and therefor the predictability of risks is unreliable" [3]. The current norm for risk assessment is using the prevention principle. The prevention principle dictates a need for action when the probability of a threat is known and deemed likely. It consequently qualifies need for action of small calculable risks leaving the large complex risks open for further destruction. So, how should risks be identified and addressed when designing for sustainability?

From this question was born the precautionary principle at the 1992 Rio Declaration on Environment and Development (Principle 15, UNCED, 1992). The precautionary principle dictates that addressing threats of serious or irreversible damage should not be postponed or thrown by the wayside when scientific certainty is lacking. It is fundamentally different from the prevention principle in that it assumes an "infinite requirement for knowledge." As such, uncertainty does not disqualify a risk from being acted upon.

Assess the Cause of Disposal and Maximize Renewal and Ruse of Resources

In designing, developing, and deploying an ICT with the primary purpose of facilitating sustainable behavior, it follows that the costs of creating and operating the ICT should not outweigh the benefits. Since invention can be identified as a cause of disposal [2], the appropriate reuse and renewal of physical and digital resources in the design of the ICT is essential in minimizing creation and operation costs. For an example of reuse of physical resources, the aforementioned local food distribution system could facilitate the creation of an overabundance of resources beyond the needs of the residence. Consequences of this may manifest themselves in waste of labor resources, soil fertility, and pest management due to rotting food. Taking the reasons for waste into careful consideration throughout the design process would produce a system design less susceptible to effects contradictory to sustainable outcomes.

To ensure the renewal of the IT as a digital resource, it would need to be designed for modularity so that components of the system can be tailored to the conditions of communities of future deployment. For example, recommendations of a distribution route leading to a central location would not make sense if that route is consistently uphill in a given community. The ICT should allow for unique scenarios and expert localizations without the need to expend resources unduly modifying the core logic of the system.

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