User-Centered Sustainable Technology Design: A Reflection on Human-Computer Interaction Research for a Sustainable Society

Extended Abstract

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Abstract

As consumers and deciders, people play the core role in tackling climate change, as their choices steer company behavior and political decisions. Human-Computer Interaction (HCI) in the sustainability domain so far focused on changing individual behavior; however, this has reached a dead end. Research has shown that extrinsic factors (such as cost and everyday convenience) mostly oppose sustainable behavior and are rarely overcome by intrinsic motivations. In this paper, we reflect on the past approaches HCI has studied to foster environmental sustainability. Bringing together recent work from environmental psychology, behavioral psychology, and HCI, we point to insights that future work could benefit from incorporating: What people think should instead be focused on what people do individually. A global identity perception can overcome moral shortsightedness, and considering people's cultural context and worldview is essential for technology to make an impact. We map such psychological aspects to user-centered technology concepts. We discuss practical implications with an emphasis on real-world applicability and critically discuss the ethics of technology. Our work sparks ideas and discussions to inspire future sustainable human-computer interaction research.

1. Human-Centered Sustainable Technology Design

Technology alone is insufficient to combat climate change; negative spillover effects (i.e., rebound effects) make people do and consume more instead of leveraging energy and resource savings to reduce emissions [1]. A change in people's behavior and attitude, and thus a strong focus on the human, are necessary. Consumption patterns and corporate behavior are two major factors that undermine decarbonization; customers control both directly and indirectly. While research in environmental psychology copes with explaining and fostering pro-environmental behaviors[2], their insights have only rarely made it into information and communication technology. Human-computer interaction (HCI), a field studying technology with a strong focus on the human, can potentially impact when incorporating concepts from environmental psychology.

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2. The Dead End in HCI for Behavior Change

Approaches in HCI that aim to support sustainability mainly focus on supporting behavior change. Building on the well-researched topic of persuasive technology (see, e.g., [3] to get an overview), research projects regarding sustainability-relevant issues such as mobility or food consumption have been conducted. However, persuasive systems have limited real-world impact, as intrinsic motivation cannot overcome external, extrinsic factors such as cost and everyday convenience and restrictions [4]. Achieved changes in behavior are often short-lasting in the wild [5] as people rarely have an extrinsic reason for adopting such systems in the long run. In their recent review, Bremer et al. [6] called for research to go beyond individual behavior change and aim for societal change.

Sustainable HCI for individual behavior change, thus, somehow, does hard making an impact, and current research advocates to expand our focus [6].

3. Conveying Pro-Environmental Norms and Values in Ubiquitous Technologies

To overcome the issues of adoption and extrinsic limiting factors outlined in Section 2, we propose that Sustainable HCI, precisely the inclusion of sustainability-oriented norms and values, should rather be a design factor in many kinds of applications instead of designing applications with the sole purpose of supporting sustainable behavior.

Convey norms and values instead of changing individual behavior directly. In behavioral models, norms and beliefs constitute the foundation for behavior. They are formed in one's youth and are largely influenced by the social bubble, one's perception of what is societally accepted (c.f. confirmation bias [1]), and content recommendation algorithms in, e.g., social media and search engines. The latter brings up content we like and thereby reinforces one's views.

Target also non-low-hanging fruit people. Systems that mainly support behavior change target only people who intend to change behavior and, e.g., help bridge the attitude-behavior gap [3]. As they already have adopted a pro-environmentally lifestyle, the potential is limited. See the limitations of persuasive technologies mentioned in Section 2. More space for impact is left when targeting people who do not directly aim for pro-environmental behavior yet. As such, people would not intrinsically use a behavior-change supporting system, ambient integration into existing everyday technology is a way to reach them.

3.1. Design Space

Therefore, we propose a set of (a) theories from environmental psychology that could support (b) HCI technologies. The resulting 2-dimensional design space, consisting of environmental psychology foundations on one axis, can be applied to human-centered technologies on the

other axis. The design space outlines novel sustainable technology concepts and inspires future work.

Psychological Concepts. A **global identity perception**, i.e., people regarding themselves as global citizens instead of part of some local group, inform beliefs about environmental justice and lead to more sustainable norms and motives [7]. Although decision models say people rate their rational decisions from a moral perspective, immoral behavior often happens subconsciously. A social, physical, and timely distance from the effects of climate change lead to **moral disengagement**. Behavioral psychology explains its factors and proposes ways to overcome moral shortsightedness that could be applied in HCI and lead to more sustainability-oriented overthinking of rational decisions [8]. The **behavior-attitude connection** describes that performing low-cost behaviors may have strong spillover effects [9], i.e., lead to further related behaviors and form norms and values. Initial small behaviors can be powerful in the long run, especially when leading to joined collective behaviors [7].

Human-Centered Technologies. **Believable agents**, conversational interfaces that express emotion and personality [10], could incorporate sustainability-oriented norms in their language. **Context-aware, ambient information** could help users classify and compare their behavior with others and different social and global groups (see also the concepts of Bemmann et al. [11]) by including them on smartphones' lock screens (c.f. [12]) or smartwatches. **Video games** can support triggering pro-social behavior, such as empathy Wulansari et al. [13]. Specific game designs or design aspects may also be evaluated to increase sustainable norms and values. Games are a promising environment through their massive adoption and usage in society. **Recommender systems**, such as social media, news feeds, and search engines, contribute to the perception of our social bubble and norms. Today, they support current beliefs and perceptions instead of widening perspectives. Lastly, applying **psychometric content targeting** approaches for good could be considered; however, their ethics must be discussed carefully [11].

4. Discussing Ethics and Future Directions

Research should discuss the ethics of such applications. Should we aim for a change in values? Where is the borderline of it being fine to try to convince people for (in our perspective) positive aims? Technologies should mind people's context, culture, and world views and emphasize ecological validity [14] to be applicable in the wild. Thus, future Sustainable HCI research has to consider the underlying psychological constructs, for example, by making projects interdisciplinary or conducting workshops with environmental psychology researchers.

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