Workshop on Sustainable Human-Work Interaction Designs: Introduction and Summary

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Abstract. Sustainability has become a global concern that requires action at all levels – from individual households to international politics. The field of human-computer interaction (HCI) contributes analyses of perceptions and practices relating to sustainability, designs of tools for acting sustainably, and critical discussions of how best to convert green attitudes into green behavior. The workshop on sustainable human-work interaction designs aimed to support HCI researchers in making such contributions by providing a forum for sharing (a) methods and processes for creating sustainable designs and workplaces, (b) case studies of experiences with introducing and learning from sustainability at work, and (c) agenda items for future research on sustainable HCI. Seven of the nine papers presented at the workshop were subsequently revised, extended, and included in this workshop proceedings volume. They investigate sustainability in households, communities, and workplaces. Individually, they provide illustrative case studies. Collectively, they contribute valuable insights about the many faces of sustainability. We hope that the workshop papers will inspire further research.

Keywords: Sustainability · Sustainable HCI · Human work interaction design

1 Introduction

The workshop on sustainable human-work interaction designs was organized jointly by the IFIP working groups on Human Work Interaction Design (WG13.6) and Human-Centered Technology for Sustainability (WG13.10). Working Group 13.6 contends that

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the integration of work analysis and interaction design is pivotal to the successful development and use of workplace systems [9]. Working Group 13.10 aims to encourage the sustainable use of resources through the design and deployment of technological systems [32]. The collaboration between the two working groups was motivated by the boundary-crossing nature of sustainability.

The aim of the workshop was to investigate ways of creating sustainable designs and workplaces by collecting case studies that analyze experiences – good and bad – with introducing and learning from sustainability at work [4]. This introduction to the workshop provides a framing for the case studies presented at the workshop and summarizes cross-cutting issues. The workshop papers, each a separate chapter in this volume, contain insightful reports on individual case studies with the overarching aim of inspiring and guiding future research on sustainable human work interaction design.

2 Designing for Sustainability at Work

Sustainability has multiple dimensions. The United Nations has formulated these dimensions in terms of goals. Its 17 sustainable development goals have become a shared blueprint for numerous initiatives to promote advances in peace and prosperity for people and the planet [34]. Another widely applied division of sustainability into dimensions is to distinguish between environmental sustainability, economic sustainability, and social sustainability [16]:

- *Environmental sustainability* is about the relationship between humans and nature. Attending to this dimension of sustainability involves that our pursuit of peace and prosperity must not deplete the planet's resources. That is, humans' current needs must be met without compromising future generations' ability to meet their needs.
- *Economic sustainability* is about the relationship between the spendings and earnings of companies (and other economic actors). This dimension of sustainability emphasizes profitability, productivity, and financial performance. Unless companies are economically sustainable, they will not be able to remain in business.
- *Social sustainability* is about relationships among people. This dimension of sustainability is rooted in constitutional human rights and in corporate social responsibility. It involves defending equal opportunities, fighting bias, promoting social justice, and pursuing personal or corporate goals in ways that do not abuse others.

Attending to sustainability involves attending to all three dimensions. In business jargon, this concomitant focus on environmental, economic, and social issues is commonly known as the triple bottom line [14]. It states that rather than focusing solely on their financial performance, businesses should also commit to measuring and following up on their environmental and social impact. To do so, they need tools and processes that support them in being environmentally and socially responsible. That is, they need sustainable human-work interaction designs. The human-computer interaction (HCI) community has taken on the design of such tools and processes [2, 6]. However, the wide scope of the challenges involved has also led to concerns about whether the extensive cross-disciplinarity required to devise effective solutions dilutes the contributions the HCI community can make [6]. In spite of these concerns, research on sustainable HCI

has burgeoned and made contributions to reduce workplace energy consumption [27], review the prospects of safely encouraging eco-driving [30], promote repair over replacement [22], explore waste sorting in public spaces [24], quantify the energy consumption of domestic food preparation [8], raise awareness of greenhouse gas emissions [23], mitigate the environmental footprint of digital infrastructures [31], support freshwater conservation [21], share indoor air-quality measurements [28], reflect on unsustainable food practices [7], maintain biodiversity [12], develop a lifecycle assessment tool for carbon accounting [3], understanding the practices of simple living [18], and many more.

The many empirical studies have also been subjected to critical reflection [e.g., 6, 13, 19, 26]. A topic in several of these reflections is the export of unsustainable elements in the product lifecycle from the global North to the global South. A grave example is the dismantling and recycling of aging ocean vessels on beaches in South Asia under unsafe and unhealthy working conditions [11]. Somewhat surprisingly, this topic is absent in the workshop papers in spite of its relevance to social sustainability.

3 Contributed Papers

Of the nine papers presented at the workshop, seven are included in this workshop proceedings volume. All papers have been revised, extended, and reviewed after they were presented and discussed at the workshop. The papers investigate sustainable human-work interaction designs at the levels of the household, community, and workplace.

Two papers research sustainability at *the household level*. The motivation for such research is the substantial resource consumption and waste production at this level, which includes both individual consumers and families. To persuade householders to change their practices, a popular approach in sustainable HCI has been eco-feedback apps. These apps provide householders with information about the greenness of their actions, such as the distribution of their electricity consumption across green-energy and fossil-fuel sources. However, eco-feedback has been criticized for presuming that more information will produce more sustainable practices, thereby overlooking the attitude-behavior gap, and for framing sustainability in an overly individual-centered manner, thereby neglecting systemic causes and collective solutions [e.g., 6, 19]. Thus, the household level is only part of the picture; it must be combined with efforts at other levels. The two workshop papers that target the household level are Goodwin and Woolley [17] and Hertzum [20].

Goodwin and Woolley [17] demonstrate that consumers can extend the functional and useful lifespan of legacy devices by working around the barriers to installing applications on these devices. Vendors such as Apple label devices as “vintage” or “obsolete” when they have not been for sale for five and seven years, respectively. These labels transition devices from a fully compatible state to an unsupported state. However, the study shows that, with some workarounds, a sizeable number of applications can still be downloaded, installed, and run on legacy devices. Thereby, the study questions whether the devices are obsolete and points to ways of reducing e-waste.

Hertzum [20] investigates how sustainability factors into 24 householders’ vacuuming practices. While the householders considered sustainability in their decisions about vacuuming, it was a minor consideration compared to other, often conflicting, factors.

The study proposes that vacuuming has similarities to routine work and that householders are likely to bring their overall attitude to sustainability with them when they go to work. This way, the household is a microcosm for studying and influencing how people reflect and act on sustainability – with some possibilities for carry-over effects to the workplace, and vice versa.

Another group of two workshop papers addresses sustainability at *the community level*. Both papers in this group investigate educational settings. The focus in sustainability research at the community level is often on enrolling community members in green thinking, for example by increasing their awareness of environmental issues or providing a forum for taking collaborative action. While sustainability research at the household level has been criticized for being overly individual-centered, sustainability research at the community level often leaves it unclear how and to what extent the initiatives can scale from their local starting point to an activity with wider impact. Scaling is important because "the processes that give rise to the issues indexed by the term sustainability are larger in time, space, organizational scale, ontological diversity, and complexity than the scales and scopes addressed by traditional HCI design, evaluation, and fieldwork methods" [33]. The two workshop papers in this group are Bansal and Lechelt [1] and Garg and Agarwal [15].

Bansal and Lechelt [1] identify the barriers that hinder the student users of a makerspace in reducing physical waste throughout their making process. Makerspaces are communal spaces that encourage material exploration and digital fabrication methods but also produce large amounts of scrap materials, leftover encasings, and other waste from the making activities. The study discusses possible strategies for encouraging both student makers and makerspace supervisors to adopt more sustainable practices. Thereby, the study supplements existing makerspace research, which tends to presume and emphasize the positive contributions of makerspaces to repair and repurposing.

Garg and Agarwal [15] present the initiatives of the HaritaDhara Research Development and Education Foundation (HRDEF) in India to build capacity for climate action among local youth, students, and professionals. The initiatives include workshops on sustainability-related curriculum topics, hands-on activity kits for experiment-based learning, and educational games for advancing the sustainable development goals. By encouraging collaboration, HRDEF aims for its initiatives to reach beyond the attendees through peer-to-peer learning in the community. The study illustrates the vast and multifaceted task of educating a large population about sustainable practices.

The third group of workshop papers addresses sustainability at *the workplace level*. To prioritize the sustainability agenda, companies often introduce the triple bottom line. It aims to ensure a consistent focus on how the company balances economic, environmental, and social sustainability, thereby aggregating operational sustainability initiatives into a managerial summary. Research on sustainable HCI focuses mainly on the operational initiatives – their tools, structures, processes, and outcomes. Multiple intervention techniques have been developed for such initiatives [35]. While these initiatives are well-intended, critics contend that the required changes to industry will not happen on a voluntary basis: "It will have to be legislated—using the kinds of tough regulations, higher taxes, and steeper royalty rates these sectors have resisted all along" [29]. For such legislation to be passed, strong community-level activities are needed to create a

mandate for politicians and legislators to act forcefully. Three of the workshop papers target the workplace level: Bouzekri and Rivière [5], Clemmensen et al. [10], and Joseph et al. [25].

Table 1. The relation of the workshop papers to the 17 UN sustainable development goals

Sustainable development goal	Goodwin and Woolley [17]	Hertzum [20]	Bansal and Lechelt [1]	Garg and Agarwal [15]	Bouzekri and Rivière [5]	Clemmensen et al. [10]	Joseph et al. [25]
No poverty							
Zero hunger							
Good health and well-being							
Quality education				x			
Gender equality							
Clean water and sanitation							
Affordable and clean energy					x		
Decent work and economic growth	x	x	x	x	x	x	x
Industry, innovation, and infrastructure	x		x			x	x
Reduced inequalities							
Sustainable cities and communities							x
Responsible consumption and production	x	x	x		x		
Climate action				x			
Life below water							
Life on land							
Peace, justice, and strong institutions							
Partnerships for the goals				x			

Bouzekri and Rivière [5] propose a design-fiction process for making energy consumption practices at work more sustainable. They specifically target the need for devising provisional practices for the period in between current and future conditions. These provisional practices must be feasible in the current work environment but must also include future practice tasks that, thereby, become relatable and testable today. Rather than focusing exclusively on the future goal, this approach facilitates and keeps track of the practice transformation that is involved in getting from the current situation to a sustainable future one.

Clemmensen et al. [10] devise and test a four-week, peer-tutoring program for training industry workers in job crafting. Job crafting is a bottom-up approach that supports workers in redesigning their own work practices to make them more personally, socially, economically, and/or environmentally sustainable. The study finds that the peer-tutoring program enabled conversations among the workers in the case company about recurrent work problems and their solutions. This way, job crafting promises to deliver sustainability through redesign. By empowering the individual worker, these redesigns are driven by those who know the details of the work processes.

Joseph et al. [25] report from a participatory-design process about the remote operation of unmanned ships for delivering goods in the domain of short-sea shipping. This way of delivering goods is more environmentally sustainable than transport by trucks over the road network. The developed scenarios and user interface focused on the factors most important to the carbon footprint of short-sea shipping – vessel size and scheduling optimization. The study illustrates how user-experience researchers can contribute to sustainability by building a holistic view of the factors involved and designing a user interface that assists the remote ship operators in attending to those factors.

The seven workshop papers span diverse issues, yet they cover only a small part of UN's sustainable development goals [34], see Table1. There is a strong and urgent need for HCI research to scale up sustainability research in work settings and beyond.

4 Conclusion

HCI research on sustainability targets multiple levels of society, in particular the household, the community, and the workplace. The papers from the workshop on sustainable human-work interaction designs report from case studies at all three of these levels. Thereby, they provide insights specific to the different levels and possibilities for cross-fertilization. We hope that the seven workshop papers included in this workshop proceedings volume will inspire future research.

Acknowledgments. Further information about the two IFIP working groups (WG13.6 and WG13.10) that organized the workshop is available at https://ifip-tc13.org/working-groups.

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