Communicating SHCI Research to Practitioners and Stakeholders

Christian Remy and Elaine M. Huang

[pre-print]

Introduction

A decade has passed since the field of SHCI (Sustainable Human-Computer Interaction) emerged (Blevis 2007; Mankoff et al. 2007), and numerous contributions to research have been made by the community. Alongside these considerable academic contributions, many members of the SHCI community have expanded their aspirations to include influencing broader environmental sustainability movements and communities. SHCI researchers have noted opportunities to communicate our work related to topics data centers (e.g., Preist et al., 2016), eco-feedback systems (e.g., Froehlich et al., 2010), or electronics waste (e.g., Remy et al., 2015). But HCI as a broad academic discipline has a long-standing "theory-practice gap" (Rogers 2004; Roedl & Stolterman, 2013), which suggests that HCI researchers struggle to communicate their work to non-academic stakeholders and practitioners. This is the focus of our chapter. We raise the question of what the limitations of SHCI's current research are in bridging this gap, particularly in our approach to communicating research contributions to stakeholders outside of the SHCI community. The term "stakeholders" is used frequently in SHCI to refer to parties of interest outside of the field; they can be designers, manufacturers, policymakers, educators, or even the broad audience of "users" of a system. In this chapter, we aim to take a closer look at those groups, in particular focusing on communities SHCI has yet to properly engage with. Learning to communicate with those diverse stakeholders is an important challenge for SHCI researchers, especially for those who wish to bridge the theory-practice gap. Oftentimes, SHCI researchers aim not simply to advance technology, but to contribute to a sustainable future—a time-sensitive and complex issue that necessitates co-operation, coordination and communication amongst many diverse stakeholders.

Therefore, the question for many SHCI researchers is: how can the field communicate its research to the various stakeholders outside the field such that it yields a noticeable real-world impact? Our approach to addressing this question comprises three steps: First, we revisit the theory-practice gap in the broader field of HCI and discuss how its lessons learned relate to SHCI. Second, we argue that the target audience for SHCI research is often not defined clearly enough and elaborate on why this is important and how this problem can be approached. Third, we highlight how we believe SHCI research needs to be framed in order to maximize impact on real-world practice. We hope that this discussion highlights opportunities for engaging with target audiences that have yet to realize the benefits of SHCI research for their practice, and sheds light on new avenues for research to improve the way we communicate our knowledge to those communities.

Revisiting the Theory-Practice Gap

The term "theory-practice gap" refers to the well-known phenomenon in HCI that insights from research rarely make their way to the relevant practice beyond the research context (Rogers, 2004). A recent study highlighted that the issue is still prevalent (Roedl & Stolterman, 2013) and was also observed in SHCI

research (Remy et al., 2015). It has been noted by design researchers (Roedl & Stolterman, 2013), in work related to interactive tabletops (Benko et al., 2009), and in theories for improving the design of user interfaces (Sutcliffe, 2000). However, there are a few success stories to be found that hint at potential solutions in bridging the gap. For example, with the Nest thermostat[1] a commercially successful solution gained a lot of attention in popular media in recent years (although it has not come out of research or have a direct connection, its design resembles findings from SHCI research). While its features focus on financial savings through heating optimization and the success in terms of permanent energy saving seems to have room for improvement (Yang et al., 2014), its design echoes a variety of conclusions the eco-feedback debate in SHCI has drawn over several years (e.g., Froehlich et al., 2010; Strengers, 2011; Pierce & Paulos, 2012).

Another increasingly popular, although not yet as widespread, design that aligns with SHCI findings are modular phones, such as the Fairphone[2], Phonebloks[3], or Project Ara[4]. The concept of modular devices has been brought up in SHCI frequently (e.g., Woolley, 2003; Blevis, 2007; Blevis et al., 2007; Huang & Truong 2008; Dillahunt et al. 2010); whether any of those works have indeed influenced any of the aforementioned designs has not been conclusively determined. However, this highlights two additional problems of the theory-practice gap: First, oftentimes research is so theoretical and vague in its conclusions that its implementation in practice is hardly recognizable. Second, when research only offers theoretical knowledge and methods without any concrete and actionable guidelines or examples, its traces in practice are not only difficult to infer, but almost impossible to prove. This is exacerbated by the circumstance that for practice outside of research, in particular in terms of industrial development, but sometimes even in education or policymaking, there is no way of knowing whether solutions were directly inspired by SHCI research findings or not unless the involved parties are surveyed (which is oftentimes unfeasible and sometimes not possible due to certain restrictions).

Exceptions are when researchers take their work themselves into practice—such as in the case of SourceMap[5] (Bonanni et al., 2010) or Avaaj Otalo/Awaaz[6] (Patel et al., 2010). It is arguable to what extent those projects count as generalizable examples for bridging the theory-practice gap, since leaving research to bring one's own projects to life does not replace the need to communicate to existing stakeholders (e.g., large corporations or public institutions). The silver lining, however, clearly is that those examples show the value in research, if only such research has the chance to create an impact in a setting beyond its original research context. The amount of impact that research has is often more subject to external, uncontrollable factors (e.g., gain widespread attention in popular media, become viral on social networks, or reach critical mass of a large early adopter user base).

In the success stories about bridging the theory-practice gap, where research made it from HCI into real-world practice, we can identify one common thread: somewhere in the process the HCI knowledge was translated and made accessible to another, usually broader audience. This may have been through that popular media, which reported on research by translating the contributions from papers into articles digestible for a general audience. In the case of SourceMap and Avaaj Otalo, the researchers themselves took their contributions and translated them into practice, together with a team of practitioners (whom they taught). As we highlighted earlier, it is sometimes difficult to argue whether or not research had a direct impact on practice; if the research is purely theoretical, corresponding real-world practice cannot be linked to and the feedback channel is missing. However, in instances where research offers insights clearly applicable to practice and examples for overcoming the theory-practice gap are present, research needs to be translated such that theory and practice can meet and establish a connection. To get to this point, it is necessary to identify, understand, and engage the target audience and their practice in order to be able to successfully communicate research to them.

Identifying and Engaging with the Target Audience

Oftentimes, research papers present concrete solutions to specific issues, but if their intention is to influence real-world practice they stay unnecessarily vague as to who those real-world practitioners are. Stakeholders, users, designers, policymakers, educators are broad terms for groups that encompass various levels of scale, expertise, and education, and this diversity poses fundamentally different challenges when being addressed. Phrasing SHCI research results using our traditional, theoretical, and abstract guidelines and principles can limit its accessibility beyond research communities and limit its real-world impact. We believe it is imperative to clearly define the target audience, become familiar with their specific requirements and needs, and engage with them as early as possible—potentially even throughout the entire research process by employing participatory design (DiSalvo et al., 2010; Silberman et al., 2014).

Acknowledging the Complex Network of Stakeholders Involved

A particularly striking example that we encountered in our own research was the sustainable design of consumer electronics, a topic very close to the concepts in Sustainable Interaction Design (Blevis, 2007) and sustainability in design (Mankoff et al., 2007). The problems we sought to address were electronic waste and obsolescence, for which SHCI research has produced a variety of solutions (Remy & Huang, 2015). The amount of e-waste is still growing (Baldé et al., 2015) and remains an unsolved and highly complex problem. What contributes to this complexity is the network of stakeholders involved. A simplistic perspective might identify two parties: the manufacturer, whose interests are mainly economical; and the consumer, who seeks pleasure and satisfaction (Woolley, 2003). However, a detailed inspection reveals that many more interest groups are involved and highly intertwined (Patrignani et al., 2011), including: “Chip Makers’ Companies, Chip Manufacturing Workers, Cloud Computing Providers, Environment Advocacy Organizations, e-waste Destination Countries, Future Generations, ICT Vendors, ICT Users, Planet Earth and Policy Makers” (and this is “a simplified version of this network” (Patrignani et al., 2011)).

In this list, one can identify some of the stakeholders mentioned frequently in SHCI research addressing obsolescence, such as manufacturers and policymakers. Note the subtle distinctions though, such as between the company and its manufacturing workers, or environmental organizations and policy makers, which have different constraints, incentives, interests, and work practices. For example, if one were to attempt to influence public policymakers, the work of external organizations that fight for environmental sustainability should be taken into account, be it through work on federal governmental level (e.g., lobbying) or more radical strategies utilizing public imagery (e.g., Greenpeace). Knowing those parties involved, their interactions, and the ways they influence each other is of critical importance to be able to successfully create an impact. One approach that researchers and organizations have pursued for many years is to address the consumer and hope for a feedback effect in which more environmentally conscious consumers force companies to take action and offer sustainable products. However, not only are other factors, such as price and aesthetics, sometimes more important to consumers (e.g., Hanks et al., 2008; Remy & Huangm 2012); this approach is also subject to “greenwashing”—companies exploit the call for greener products by exaggerating their sustainable options. Approaching the problem head-on, e.g., by attempting to target the manufacturer rather than the user, can help mitigate those issues (e.g., Blevis, 2007; Khan, 2011).

While the stakeholder’s network is complex in the case of physical artifacts, such as our example of consumer electronics, it might even be more complex to model such a network in other problem areas that SHCI attempts to address. For example, when developing concepts that seek to raise awareness, change behavior, or promote knowledge, SHCI has often focused on the most visible stakeholders (i.e., the users)

and neglected other parties (e.g., public policymakers or corporations). This issue is not new and has been brought up several times in seminal SHCI publications, with specific calls for researchers to shift focus from the individual to include other stakeholders or treat the common group of "users" differently (e.g., DiSalvo et al., 2010; Dourish, 2010; Brynjarsdottir et al., 2012; Silberman et al., 2014). Despite calls to change the practice of SHCI research, there are few clear signs of work that responds to those calls to action and fundamentally changes how researchers approach those problems—rather, research seems to shy away from this problem domain. We argue that instead SHCI researchers need to go one step further to identify the complex network of stakeholders. Who are additional potential stakeholders in those practices have not even been identified yet? When communicating sustainable information to consumers to raise awareness and facilitate behavior change, which parties are involved besides the researcher, the consumer, and the technological artifact?

We highlighted earlier that policymakers are influenced by external factors—public pressure, appointed advisors, lobbyists, and many more—and assuming those as a suitable target audience can be one potential lever to change the game and open up new avenues for research to create an impact. What if one of the shortcomings of eco-feedback technology and other research in SHCI that attempted to raise awareness and change behavior was that external stakeholders who influenced the decision making and daily routines of users were not properly acknowledged? For example, aiming to change people's transportation behavior through eco-feedback technology could potentially be jeopardized by their social network or business contacts directly or indirectly influencing the decision making process—potentially in the exact opposite way. We believe that it is critically important to make an effort to model the entire network of interest groups, at least to the extent possible, with all its facets to gain a holistic view of the problem domain and be able to identify new avenues for research. This increases the chance for SHCI research to successfully communicate their insights to practitioners outside of the community, by translating it into the target audience's language, as we have learned from previous theory-practice gap examples.

Engaging with the Practitioners' Practice

Knowing the stakeholders relevant to the problem domain is only the first step in communicating SHCI knowledge. Once we map the stakeholders, we should work to understand their unique practices and expertise. Doing so might allow us to identify opportunities to fuse SHCI research with the stakeholders' work processes, and bridge the theory-practice gap.

Going back to the example of designing sustainable consumer electronics to counter obsolescence, we identified in our research that the term "designer" was much too vague and did not sufficiently describe the work practices of those we sought to engage. Industrial designers, interaction designers, graphics designers, fashion designers, and even architects all fall under the umbrella term of designers and share commonalities in their practice, such as the iterative cycles when developing solutions. However, the detailed models of work practice of product design (Kruger & Cross, 2006), design engineering (Cross, 2008), architecture design (Lawson, 2006), and interaction design (e.g., Nielsen, 1994) show important differences. And even within one particular discipline other factors come into play, such as different levels of expertise (Cross, 2006; Gonçalves et al., 2011) that highlight different problem-solving strategies (Kruger & Cross, 2006). Depending on those nuances, deciding on whether to translate SHCI design knowledge into textual or visual advice can have a significant impact on its use in practice (e.g., Muller, 1989; Goldschmidt & Smolkov, 2006; Goldschmidt & Sever, 2011). As highlighted in prior research, not only knowing those differences but translating research to be able to incorporate it into those designers' routines increases the chance to overcome the theory-practice gap (Remy et al., 2015).

While identifying the breadth of the potential target audience is the first step, investigating and understanding its everyday work practices are no less important task that should follow immediately. To communicate research to those stakeholders, previous examples we mentioned earlier highlighted that mediators translated the research into a language that was catered towards the target audience beyond the research community, as well as conveyed it in the most useful context. However, to be able to do this translation and be able to connect to the stakeholders, it is imperative to know their language and practices by engaging with them and getting to know their routines. For example, when news outlets cover research projects and translate them into online articles with the goal to go viral, they write them in a way that is not only understandable by a large audience (i.e., avoid complex terminology), but frames them in a way that invites the reader and sparks their interest (i.e., "catchy headlines") and fits into their daily news consumption routines (i.e., short and simple rather than long and detailed). Therefore, in the next section we will discuss in detail how to transfer those insights and principles from translating research into our domain of SHCI knowledge.

How to Frame our Research to Reach the Relevant People?

When presenting SHCI research within our community, we can assume some degree of shared background, expertise, and expectations – thus, the framing of such research focuses less on the motivation but rather on the contribution. However, when communicating research to practitioners outside of SHCI, we should ask ourselves: how is SHCI research relevant to the target group's practices? Are they aware of existing SHCI research relevant to their practice? Are there opportunities for the target group to incorporate specific SHCI research insights into their real-world practice? Do they need an incentive to do so? These and other questions need to be addressed when framing SHCI research knowledge to be applied to practice outside of our field. HCI and SHCI research have already touched upon some of those questions (Dourish, 2006; DiSalvo et al., 2010; Silberman et al., 2014), and insights from previous attempts at addressing the theory-practice gap hint at possible solutions (e.g., Dalsgaard & Dindler, 2014; Remy & Huang 2015). In the following, we discuss how researchers in SHCI could frame their work to make it accessible for practitioners and achieve successful knowledge transfer. We also acknowledge that this is sometimes at odds with typical research practice and highlight benefits as well as obstacles.

Translate SHCI Knowledge

The first and most important step to make SHCI knowledge accessible for practitioners outside the field is to translate it into their domain's language. When researchers communicate their findings, such as in scientific presentations and publications, the language oftentimes contains genre-specific words and phrases that can pose a barrier for practitioners. For example, HCI has its roots in computer science and disciplines related to psychology; terminology that is considered to be basic jargon in those fields might lead to confusion or misunderstanding for people with other expertise. Moreover, the history, tools, and methods from those fields are the foundation of HCI research and are therefore critical for understanding research contributions; however, in aforementioned scientific presentations and papers they are often only briefly explained, if at all, since other researchers are familiar with those well-known foundations. Using genre-specific jargon and omitting details describing those foundations helps authors to keep their information more concise when communicating it to other researchers in the field, but can also make it difficult for practitioners to understand if they do not have this background knowledge.

Therefore, it is important to translate SHCI knowledge into the target audience's language to avoid such confusion or misunderstandings and make the research contributions more accessible. Translating can be understood literally in this case, as it describes the act of replacing words that are genre-specific

terminology with terms familiar to the target audience, as well as describing practices that might be self-explanatory for domain experts. Oftentimes omitting details rather than describing them can help to avoid confusion ("less is more"); focusing on the results and the takeaways instead of elaborating on the methodology when it is not the key aspect the practitioner is interested in. An important point is to realize that for successful application of SHCI design knowledge, some practitioners might not necessarily need to understand how those contributions were conceived of, but they need to be able to incorporate it into their practice when most appropriate (Remy et al., 2015).

This leads to the second major point in translating SHCI knowledge: enabling practitioners to apply the research findings to their processes and incorporate it into their routines. Being able to understand SHCI knowledge bridges the first gap between researchers and practitioners, but it does not guarantee that the practitioners will be able to use them in their work practice. It is crucial for researchers to understand the target audience's work practice such that the findings can not only be translated, but also be appropriated to fit into their routines. For example, if the lessons learned from a research project are concrete guidelines for the choice of material in designed products, this might be more relevant to later stages in the design process (Kruger & Cross, 2008). Other guidelines and requirements, such as ISO standards or material properties as stated in the design brief, might come into play that compete with the SHCI design principles. In this case, the guidelines should be in a similar format and scope to other information provided at this stage. On the contrary, if SHCI design principles propose more foundational ideas that regard the overall concept of a designed object, applying those as early as possible in the process might be most beneficial (Khan, 2011).

Undeniably, this requires additional effort on the researcher's part: first and foremost, learning about the target audience's practice (e.g., from domain-specific literature or through exploratory studies such as interviews or surveys) – but also testing the translation of SHCI knowledge (e.g., recruiting practitioners and conducting a test run in a setting as close as possible to real-world practice). In the following, we discuss the opportunities that arise from this additional effort, but also how this knowledge transfer relates to existing research practice.

Opportunities and Limitations

Translating scientific knowledge to make it more accessible to a broader audience is similar to the aforementioned example of news stories reporting on scientific findings: the headline and conclusion often boil research down to a single sentence, and fail to confront the reader with the complexity of research. While the skill set required is similar—being able to understand both the research as well as the receiving end and having the ability to translate knowledge from one to the other--there is an important difference when bridging the theory-practice gap. When communicating SHCI knowledge to practitioners, the target audience is known and quite narrow, unlike in the example of news about scientific contributions which are meant to reach as many people as possible. This allows for a much more specific translation of knowledge; it is not just simplifying research contributions into shallow principles but adapting them to a different environment.

Several opportunities arise which researchers can seize in order to maximize benefit for their own research as well as the entire research field. First, engaging with the target audience to understand their practices and understand how one's research fits into it allows for a new perspective, potentially uncovering new directions for a specific project. Some of the contributions will prove to be more useful than others, and those pointers can be valuable for identifying which strains of research are most promising for future work. Second, the ability to communicate one's research to a different discipline and practitioners outside of the well-known research domain can prove to be a valuable skill in the future; for example, when negotiating funding for follow-up projects or attempting to gain more publicity for a

research lab or entire conference. Third, bridging the theory-practice gap yourself rather than waiting for practitioners to pick up your findings and apply them yourself creates a direct feedback channel between research and practice. As mentioned in the beginning, practitioners take note of research and apply the findings in their daily processes, but oftentimes there is no feedback to the researchers once this knowledge transfer has occurred, in particular in the case of failure. Fourth, establishing connections to practitioners who can apply your research offers potential for collaboration and future research (e.g., by engaging in public policy projects (Thomas, this text) or teaching SHCI knowledge (Eriksson & Pargman, this text)).

Those opportunities come at the cost of additional effort; studying a different discipline and understanding their language, their work practices, and their daily routines takes time and resources, and so does translating SHCI design knowledge as well as testing the translation. This is oftentimes at odds with existing pressure of researchers to meet deadlines and publish at conferences and in journals—and communicating SHCI knowledge to practitioners is not a practice that can replace those activities. Rather, it can extend existing research practice, bring more exposure to a researcher's specific project as well as potentially the entire field, and therefore pay off in a different form, making up for the invested additional effort. We believe that in areas where engaging with practitioners is as crucial as in ours, due to the time pressure of issues of climate change, the additional effort is not only worth it but is almost required to keep SHCI active and alive. Targeting practitioners is also just one potential way to gain more exposure; others include engaging with issues of politics and economy (Nardi & Ebkia, this text) or investing into participatory design (Davis & Gram-Hansen, this text).

Conclusion

In this chapter, we argue that current SHCI research needs to rethink the way it is communicating its knowledge to practitioners outside the field to create a real-world impact on environmental sustainability. In particular, we highlight what the limitations of the current output of SHCI research are, why the vague definition of target audiences can jeopardize our research efforts, and how we need to frame our work differently. We emphasize once more that this is not to replace current publication practice, but add new, additional ways of communication—specifically suited towards reaching out to practitioners and stakeholders.

References

Baldé, K., Wang, F., Huisman, J., & Kuehr, R. (2015). *The global e-waste monitor – 2014*. Bonn, Germany: United Nations University, IAS – SCYCLE.

Benko, H., Morris, M. R., Brush, A. J. B., & Wilson, A. D. (2009). *Insights on Interactive Tabletops: A Survey of Researchers and Developers* (No. MSR-TR-2009-22).

Blevis, E. (2007). Sustainable interaction design: Invention & disposal, renewal & reuse. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 503–512). New York, NY, USA: ACM.

Blevis, E., Makice, K., Odom, W., Roedl, D., Beck, C., Blevis, S., & Ashok, A. (2007). Luxury & new luxury, quality & equality. In *Proceedings of the 2007 Conference on Designing Pleasurable Products and Interfaces* (pp. 296–311). New York, NY, USA: ACM.

Bonanni, L., Hockenberry, M., Zwarg, D., Csikszentmihalyi, C., & Ishii, H. (2010). Small business applications of Sourcemap: A web tool for sustainable design and supply chain transparency. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 937–946). New York, NY, USA: ACM.

Brynjarsdottir, H., Håkansson, M., Pierce, J., Baumer, E., DiSalvo, C., & Sengers, P. (2012). Sustainably unpersuaded: How persuasion narrows our vision of sustainability. In *Proceedings of the 2012 ACM*

Annual Conference on Human Factors in Computing Systems (pp. 947–956). New York, NY, USA: ACM.
Cross, N. (2008). *Engineering design methods: Strategies for product design*. Chichester, England; Hoboken, NJ: J. Wiley.
Dalsgaard, P., & Dindler, C. (2014). Between theory and practice: Bridging concepts in HCI research. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1635–1644). New York, NY, USA: ACM.
Dillahunt, T., Mankoff, J., & Forlizzi, J. (2010). A proposed framework for assessing environmental sustainability in the HCI community. In *Examining Appropriation, Re-Use, and Maintenance of Sustainability workshop at CHI 2010*.
DiSalvo, C., Sengers, P., & Brynjarsdóttir, H. (2010). Mapping the landscape of sustainable HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1975–1984). New York, NY, USA: ACM.
Dourish, P. (2006). Implications for design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 541–550). New York, NY, USA: ACM.
Dourish, P. (2010). HCI and environmental sustainability: The politics of design and the design of politics. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (pp. 1–10). New York, NY, USA: ACM.
Froehlich, J., Findlater, L., & Landay, J. (2010). The design of eco-feedback technology. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1999–2008). New York, NY, USA: ACM.
Goldschmidt, G., & Sever, A. L. (2011). Inspiring design ideas with texts. *Design Studies*, *32*, 139–155.
Goldschmidt, G., & Smolkov, M. (2006). Variances in the impact of visual stimuli on design problem solving performance. *Design Studies*, *27*, 549–569.
Gonçalves, M. G., Cardoso, C., & Badke-Schaub, P. (2011). Around you: How designers get inspired. In *Proceedings of the 18th International Conference on Engineering Design*.
Hanks, K., Odom, W., Roedl, D., & Blevis, E. (2008). Sustainable millennials: Attitudes towards sustainability and the material effects of interactive technologies. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 333–342). New York, NY, USA: ACM.
Huang, E. M., & Truong, K. N. (2008). Breaking the disposable technology paradigm: Opportunities for sustainable interaction design for mobile phones. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 323–332). New York, NY, USA: ACM.
Kruger, C., & Cross, N. (2006). Solution driven versus problem driven design: Strategies and outcomes. *Design Studies*, *27*, 527–548.
Lawson, B. (2006). *How designers think: The design process demystified*. Oxford; Burlington, MA: Elsevier/Architectural.
Mankoff, J. C., Blevis, E., Borning, A., Friedman, B., Fussell, S. R., Hasbrouck, J., Woodruff, A., & Sengers, P. (2007). Environmental sustainability and interaction. In *CHI '07 Extended Abstracts on Human Factors in Computing Systems* (pp. 2121–2124). New York, NY, USA: ACM.
Muller, W. (1989). Design discipline and the significance of visuo-spatial thinking. *Design Studies*, *10*, 12–23.
Nielsen, J. (1994). *Usability engineering*. San Francisco, Calif.: Morgan Kaufmann Publishers.
Patel, N., Chittamuru, D., Jain, A., Dave, P., & Parikh, T. S. (2010). Avaaj Otalo: A field study of an interactive voice forum for small farmers in rural India. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 733–742). New York, NY, USA: ACM.
Patrignani, N., Laaksoharju, M., & Kavathatzopoulos, I. (2011). Challenging the pursuit of Moore's law: ICT sustainability in the cloud computing era. *POLITEIA*, *XXVII*.
Pierce, J., & Paulos, E. (2012). Beyond energy monitors: Interaction, energy, and emerging energy systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 665–674). New York, NY, USA: ACM.

Preist, C., Schien, D., & Blevis, E. (2016). Understanding and mitigating the effects of device and cloud service design decisions on the environmental footprint of digital infrastructure. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1324–1337). New York, NY, USA: ACM.

Remy, C., Gegenbauer, S., & Huang, E. M. (2015). Bridging the theory-practice gap: Lessons and challenges of applying the attachment framework for sustainable HCI design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1305–1314). New York, NY, USA: ACM.

Remy, C., & Huang, E. M. (2012). The complexity of information for sustainable choices. In *Simple, Sustainable Living workshop at CHI 2012*.

Remy, C., & Huang, E. M. (2015). Addressing the obsolescence of end-user devices: Approaches from the field of sustainable HCI. In L. M. Hilty & B. Aebischer (Eds.), *ICT Innovations for Sustainability* (p. 474). Switzerland: Springer International Publishing.

Roedl, D. J., & Stolterman, E. (2013). Design research at CHI and its applicability to design practice. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1951–1954). New York, NY, USA: ACM.

Rogers, Y. (2004). New theoretical approaches for human-computer interaction. *Annual Review of Information Science and Technology*, *38*, 87–143.

Silberman, M. S., Nathan, L., Knowles, B., Bendor, R., Clear, A., Håkansson, M., Dillahunt, T., & Mankoff, J. (2014). Next steps for sustainable HCI. *Interactions*, *21*, 66–69.

Strengers, Y. A. A. (2011). Designing eco-feedback systems for everyday life. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2135–2144). New York, NY, USA: ACM.

Sutcliffe, A. (2000). On the effective use and reuse of HCI knowledge. *ACM Trans. Comput.-Hum. Interact.*, *7*, 197–221.

Weiser, M. (1991). The computer for the 21st century. *Scientific American*, *265*, 94–104.

Woolley, M. (2003). Choreographing obsolescence - ecodesign: the pleasure/dissatisfaction cycle. In *Proceedings of the 2003 International Conference on Designing Pleasurable Products and Interfaces* (pp. 77–81). New York, NY, USA: ACM.

Yang, R., Newman, M. W., & Forlizzi, J. (2014). Making sustainability sustainable: Challenges in the design of eco-interaction technologies. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 823–832). New York, NY, USA: ACM.

[1] https://en.wikipedia.org/wiki/Nest_Labs

[2] http://www.fairphone.com/

[3] http://phonebloks.com/

[4] https://atap.google.com/ara/

[5] http://www.sourcemap.com/

[6] https://www.awaaz.de/