

Out of Control: Reframing Sustainable HCI Using Permaculture

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ABSTRACT

Sustainable HCI research is often framed in terms of correction and control, such as designing persuasive technology to encourage individual behavior change or to optimize energy consumption. But as others have argued, correction and control-based approaches detach sustainable HCI from the sociotechnical realm, e.g., by oversimplifying the complexities of the social world and how they participate in unsustainable practices. Many agree that the sustainable HCI community needs to move beyond persuasion and behavior change--but how? In this paper, we introduce an alternative to the control paradigm. We turn to the philosophy of permaculture, which emphasizes working *with* nature rather than against it, as the control model does. Specifically, we present our fieldwork in contemporary agriculture in Taiwan, which experiments with permaculture-based approaches to agriculture, blending ancient traditions of farming with cutting edge technologies and philosophies. This work demonstrates how permaculture philosophy's alternative to the control model creates potential openings and new framings for sustainable HCI.

CCS CONCEPTS

• Human-centered computing → Field studies • Human-centered computing → HCI theory, concepts and models • Theory of computation → Interactive computation

KEYWORDS

Sustainable HCI, Sustainability, Permaculture, Control, Farming

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1 INTRODUCTION

Bridging environmental sustainability and interaction design, sustainable HCI emerges as an opposition to uncontrolled industrialization and thoughtless urbanization [7,35]. One major focus of this discourse is to design persuasive technologies that "convince users to behave in a more sustainable way" [15]. In other words, the community often relies on the metaphor of correction (e.g., unsustainable user behavior) and control (e.g., energy consumption). For example, Woodruff and Mankoff [55] stress the actions of tracking and regulation by pointing out that "environmental sustainability involves efforts such as monitoring the state of the physical world; managing the direct and indirect impacts of large-scale human enterprises such as agriculture, transport, and manufacturing; and informing individuals' personal choices in consumption and behavior [p.19]".

Building on this perspective, predicting and monitoring energy consumption comprises a large portion of the sustainable HCI corpus [e.g., 12,19,29,33,40,54,55], and the general purpose of sensing user behavior and providing eco-feedback is to assist decision making or increase the awareness of undesirable behaviors [e.g., 7,11,18,22,23,25,34,38,47,56]. These papers tend to frame sustainability as an awareness and persuasion problem: "rais[ing] awareness of sustainable travel opportunities" [37], "support[ing] people's sustainable intentions" [50], and "stimulate[ing] cooperatives [to] reduce [...] collective energy use" [25]—all can be traced back to the goal of persuasive technology proposed by Fogg [20]—"to create an intervention that succeeds in helping the target audience to adopt a very simple target behavior that can be measured." As we have argued above, the sustainable HCI research community has been focusing in part on "controlling" resource consumption and "correcting" unsustainable user behavior.

More recently, sustainable HCI researchers have begun to reveal the limitations of defining and exploring sustainability under the model of "control and correction." For instance, Brynjarsdóttir et al. argue that persuasive sustainability over emphasizes resource conservation, optimization, and predictability, making it conceptually detached from complex reality of everyday life [10]. Møllenbach et al. reveal that persuasive technology tends to neglect the societal norms and macrostructure while focusing too much on facilitating individual behavior change, making sustainability an unrealistic pursuit [38]. The importance of embedding sustainable design interventions in

the context of political relationship and social structure is shared by many others [e.g., 13,14,16,17,26,30,39,41,42,46].

Informed by these studies, we explore opportunities for building sociotechnical systems that goes beyond the purpose of persuasion and behavior change. Our intention is not to criticize the control and correction model as intrinsically bad, but to look beyond it, to identify alternative framings of sustainable HCI. To do so, we draw from the philosophy of permaculture, which emphasizes on the harmonious integration of "land, resources, people, and the environment through mutually beneficial synergies" to create ecosystems that are resilient, diverse, and productive [65]. We use our ethnographic work in contemporary agriculture in Taiwan as a case to illustrate how the theory of permaculture can be productive as an alternative framing for sustainable HCI. We make the following contributions in sustainable HCI: (1) We unpack farming practices in Taiwan through the lens of permaculture to illustrate how the model of working *with* nature provides an alternative to unsustainable industrial agriculture. (2) We demonstrate ways HCI researchers might reimagine environmental sustainability by actively cultivating human-nature collaboration and providing care to benefit other life forms.

2 PERMACULTURE: AN ALTERNATIVE TO CONTROL

Permaculture (permanent agriculture) is a term coined by biologist Bill Mollison and environmental designer David Holmgren building on prior work on sustainability [40]. Witnessing the environmental crisis brought about by uncontrolled industrialization and thoughtless urbanization, they oppose the dominant idea of human being the "conqueror" of the world with natural environment as the servant [39]. Permaculture advocators consider industrial agriculture unsustainable because it exploits non-renewable resources (e.g., fossil fuels) to power farming machineries and fabricate chemical fertilizers and pesticides, which then brings destructive ecological disasters to the environment (e.g., soil depletion, greenhouse gas emission, pollution, and breeding of resistant pest strains) [6,30]. Responding to these problems, permaculture advocates a harmonious and collaborative relationship between human and nature (e.g., animals, plants, microorganisms) while rejecting actions of control and dominance as they are widely embedded in industrial agriculture practices, including using chemical fertilizers that kills microorganisms in the soil or spraying pesticides that slaughters the critters in the farmland [6,27,30,40,65].

We are interested in the way that permaculture and current sustainable HCI research both surface issues of control; we note that the permaculture philosophy's critique of "against" nature mirrors arguments that some HCI researchers [e.g., 8,13,35]. have made critiquing the control and correction framing of sustainable HCI. With a few exceptions [e.g., 6,15,25,45], permaculture remains relatively unexplored in HCI. However, we find it relevant to sustainable HCI because it presents an opportunity to move beyond the dominate and control model (e.g., human as conqueror). As Mollison [39] puts it, "the philosophy behind permaculture is one of working *with*, rather than against, nature [35, p.iX, emphasis added]", we argue that permaculture provides an alternative model that emphasizes on the metaphor of cooperation (e.g., human as collaborator). In the ensuing sections, we use permaculture to unpack farming practices in Taiwan.

3 RESEARCH SITES AND METHODOLOGY

The ethnographic work we present here draws from the authors' long-term research program in Taiwan on topics of making, DIY, innovation, and cultural and creative industries beginning 2011 to the present [e.g., 1,2,3,20,21,31]. In the context of this paper, we focus specifically on the ethnographic fieldwork conducted during June and July in 2017. Research sites were chosen to reflect different styles and approaches of permaculture-based farming, including organic farming, eco-friendly farming, small-scale farming, and farm hacking. Two of the authors are natives of Taiwan; the other has conversational competence in Mandarin. The interviews were conducted in Mandarin Chinese. We also collected and analyzed policy documents on eco-friendly farming.

For permaculture-based tea farming, we focus on Pinglin, a rural town in Taiwan located in the mountainous area in the south of Taipei City. 80% of the residents in Pinglin are involved with tea-related activities on a daily basis, including growing, processing, managing, and trading [31]. Conventional tea cultivation relies heavily on pesticides and fertilizers to ensure the beauty and juiciness of tea leaves, and the quantity of tea that can be harvested in any given season; however, because of Pinglin's unique geological location, local tea farmers work closely with government administrations (e.g., Agriculture department in New Taipei City government, tea research and extension station under Executive Yuan), research institutions (e.g., National Taiwan University Graduate Institute of Building & Planning), and non-profit organizations (e.g., Tse-Xin organic agriculture foundation) to experiment with different ways of cultivation [11,64,66,67].

The ethnographic fieldwork also includes visiting Yuanshan township, a rural town in Yilan County. Located on the west side of Lanyang Plain, its inhabitants are primarily farmers, and rice paddies comprise a typical scenery of this area [68]. In recent years, Yuanshan township has attracted a significant number of small-scale farmers, many of whom are experimenting with alternative farming techniques, making it a unique site for studying contemporary Taiwanese agricultural practices. Many of these farmers are former city dwellers with diverse professional backgrounds, ranging from law, engineering, and biology to design, architecture, film making, and culinary pursuit. One can find various kind of "half farmer, half X": for example, there is a farmer who also runs a second-hand bookstore combined with locally produced groceries; another who creates self-made farming devices using open source technology; another who has over 27K followers on Facebook who are interested in her visual storytelling illustrating her farming life; another who also owns a restaurant that uses fresh local ingredients; as well as farmers who come from different parts of the world to experience alternative

ways of living. Informing these alternative ways of living is the philosophy of permaculture. Elsewhere in the world, permaculture has helped shape transition towns, in which communities prepare their towns for the world after peak oil [1,5,24]. The Yuanshan township has not formally embraced this language—none of our informants ever mentioned the idea of a transition town—but clearly Yuanshan and transition towns share certain affinities.

4 OUT OF CONTROL: PERMACULTURE-BASED APPROACHES IN TAIWAN

Our fieldwork in Taiwan's Pinglin and Yuanshan townships reveals an alternative model to traditional industrial agriculture and factory farming (i.e., maximizing agribusiness profits at the expense of environment, animal welfare, and human health), one that is informed by the philosophy of permaculture. In what follows, we use the notion of "working *with* nature," one of the key concepts in permaculture to unpack Taiwanese farming practices in these two towns. We focus in particular two aspects of *working with nature*: Collaboration and care.

4.1 Working with as cultivating collaboration

We visited organic tea farms in Pinglin in the summer of 2017 and interviewed several tea farmers and policymakers. Tea farmer Chen Lu-He (陳陸合), a Pinglin native, spent much of his career at Panasonic before retiring and returning to his hometown to take up farming. Chen was financially stable at this phase of his life, so he wanted to experiment with ways that he can give back. Chen is known for being a pioneer in organic farming in Pinglin, nicknamed the "frog king" for his dedication to preserving local environment and wildlife [62]. We visited Chen's Green Light tea farm (綠光農園, Figure 1), which sits on top of the mountains overlooking Beishi River, one of the water sources of the Feitsui Dam that a quarter of the total population in Taiwan relies on.

Previous research [e.g., 10,48,53,57,58,60] has shown that Taiwan's world-famous Oriental Beauty (東方美人茶) and honey scented tea (蜜香茶) is a result of tea farmers having an effective relationship with non-human actors (in this case, bugs) in tea cultivation. In fact, Oriental Beauty and honey scented tea become popular because of a distinctive fruity and sweet-like-honey aroma during brewing. These aromas are triggered by Jacobiasca Formosana (小綠葉蟬), a small leaf hopper that feeds on tea buds and leaves. Chen showed us how to recognize the "infected" leaves (Figure 2): "*This leave has been stung by the leafhoppers, that is why it's yellow and stunted… if you don't use spray pesticide you will see these leafhoppers in the tea farm.*" The leafhoppers are extremely small, measuring just 0.1-inch-long, making it hard to be detected through naked eyes. Farmers in Taiwan often call them *ian-a* (蝘仔) or *fuchenzi* (浮塵子, written as "floating dust" in Chinese) to illustrate their diminutive size and prevalence during summer and autumn when their population peak [56]. Chen pulled out his phone to show us a close-up of this insect. He also showed us the needle-like proboscis of the leafhoppers, which penetrates the tissues of the tea leaves for its juice. The insect-bitten tea leaves produce two kinds of chemicals: one is the so-called ian-a smell (蝘仔味), which attracts spiders that eat the offending leafhoppers; another chemical repairs its damage, resulting the natural honey scent during tea brewing. Recent biochemical studies indicate that the damage done by the leafhopper activates a defensive response and significantly increases a fragrant compound in the composition, which attributes to the sweet note of the tea [51,69]. It is worth mentioning that the quality and quantity of tea depends heavily on the leafhoppers—the damage has to be done at the right amount and at the right time, because tea leaves of different ages react differently to the same bite, and too much damage increases the bitterness of the tea [52].



Figure 1: A corner of Chen's Green Light tea farm. Tea trees grow together with trees, flowers, grass, and weeds.



Figure 2: The yellow and stunted foliage in the back is infected by leafhopper; the ones rolled up are nested by tea tortrix; and the others with burning dots are attacked by stink bugs.

Cultivating Oriental Beauty (東方美人茶) and honey scented tea (蜜香茶) thus involves an intricate interaction between farmer and the non-human world, where leafhoppers are key actors. While leafhoppers cause physical damage to the foliage and reduce the yield of the season, they also contribute to the production of the distinct honey aroma, making the tea a highly sought-after commodity. Organic tea farmers actively facilitate an alternative engagement with the natural environment by relinquishing control, including the use of both fertilizers and pesticides. In her exploration of permaculture movement as an alter-biopolitical intervention, Maria Puig de la Bellacasa describes permaculture ethics as the engagement with "the consequences of living in naturecultures, recognizing the *interdependency* of all forms of life – humans and their technologies, animals, plants, microorganisms, elemental resources such as air and water, as well as the soil we feed on. It

thus decentres human ethical subjectivity by not considering humans as masters nor even as protectors of, but as part of earth's living beings [46]." In the case of tea farmers and leafhoppers in Taiwanese tea farms, by decentering the needs of the human (i.e., maintaining bugs-free tea farms), a different relationship between the non-human and human emerges, one that is based on appreciation, affection, and responsibility as opposed to conflict and competition.

The other non-human entity in Chen's narrative—the spiders that play a role in the control of leafhopper population—illustrate different specificities of human-nonhuman configurations, one that acknowledges and respects the agency of the non-human (i.e., the spiders) to maintain biodiversity.

A skeptical reader might consider Chen's tea farm as yet another example of control—one that is carefully arranged to attract leafhoppers to consume the foliage, triggering the defensive mechanism in the leaves to release a unique honey scented aroma and elevate the value of the tea. A recent agriculture research project attempted to generate the unique honey aroma and mass produce Oriental Beauty by injecting tea leaves with identical chemical compounds that are original produced by the leafhoppers [51]. In this counter scenario, humans replicate and take full control of the production of honey aroma mechanism in a lab setting, taking the leafhoppers and spiders out of the equation completely. The difference between the two models is clear: While one focuses on *instrumentality*, requiring less time, and thus ensuring greater and more reliable availability of the honey scented teas, the other is about *cultivation* and sustainable collective caring, an aspect of permaculture we shall turn to in the next section.

4.2 Working with as providing care

The story of Oriental Beauty, honey scented tea, and leafhoppers captures the notion of *cultivation* while work with nature: one where humans move away from mode of control to nurture a collaborative, interconnected relationship with nature. In this section, we show how farmers in Yuanshan township work with nature, focusing primarily on the practice of threshing. Threshing is a process of separating grains from straws and husks. We participated in threshing during our fieldwork in Yuanshan by working closely with Jeff and Sophia, a husband and wife team who have a successful architectural firm in Manhattan, New York, and Shanghai before returning to Taiwan to take up farming. The reason for the turn to farm life is in part due to the fact that their son had had severe allergy when they lived in those big cities. They returned to Yuanshan in 2013 to care for their son and pursue a simpler, cleaner way of living.

We first met Jeff and Sophia at their rice paddy on a scorching hot and humid summer morning. There are hundreds of rice paddies in the village, and while most of the paddy fields look very similar, theirs stand out because of the triangular-shaped racks that are lined up nearly in the rice paddy. These racks are made by using bamboo as the main frame and metal tubes as the hanging structure, secured with cotton ropes. These racks are one of a kind and are used to hang harvested stalks prior to threshing and hold the straws after threshing (Figure 3).

Jeff and Sophia showed us how to thresh: We collected the straws, remove the weeds, spread the stalks evenly, put them into the threshing machine to collect grains, and then put the straws back onto the triangular racks (Figure 3). By closely handling the crops, we soon noticed that there were many "leftover" grains on the straws (Figure 3). Jeff explained that this is because the threshing machine can only function within a certain range, so the grains outside of the range will stay intact. We asked if they want to put the straws back into the threshing machine to collect remaining grains, they declined, much to our surprise, "*we want to protect the ecosystem, so it's okay to leave some grains on the straws for the birds to eat.*" This statement illustrates the permaculture philosophy of working *with* nature.



Figure 3: The triangular racks made of bamboos and metal tubes, and the straws hanging on the rack.



Figure 4: (Left) spread stalks evenly for threshing. (Right) left-over grains on the straw.

What one might consider as a wasteful behavior at the first blush turns out to be a deliberate consideration, an act of *care* of the rice farmers. Jeff and Sophia choose not to collect the remaining grains, nor did they decide to burn the straw (which is a fast, low-cost practice among many farmers to dispose straws and clear the land in preparation for seeding [70]); instead, they fabricated aesthetic and sturdy racks that prop up the straws so birds can feed on the remaining grains. As a permaculture evangelist and practitioner, Jeff refers this practice to the permaculture ethic of "return of the surplus" [39]. He observes, "*In a narrow sense, permaculture is about social justice, but in a broader sense, it is about how you keep the (environmental and social) engine running. What you want to create is a loop rather than a linear process... in fact, there is no waste in nature.*" To Jeff and

many like him in Yuanshan, sharing what he doesn't need contributes directly to regeneration of resources. He continues, "*we learn how to live in the natural environment so that we do not implement too much intervention; we simply follow a natural process to help create and maintain an environment where everything is abundant.*" In the case of Jeff's threshing practice, it's clear that Jeff considers sharing what he doesn't need as an act of reducing human intervention; additionally, returning surplus to the nature is not just an ethical consideration, but an approach to sustain, even regenerate, resources to "keep the engine running."

Jeff and Sophia's threshing practices illustrates an act of *caring*. By making the decision not to exhaust or discard extra resources, they are able to share it with other non-human forms who might benefit from it. If we see the control model (e.g., in industrial agriculture as human overpowering and manipulating nature, working *with* nature (e.g., in permaculture) would reposition human as only one of the actors and not the dominant one. As Jeff puts it, "*we are not [so much like] farmers but more like gardeners (園丁). In the context of farming, we provide care to the environment and plants to obtain [only] what we need to survive […] and share the rest with others that include non-human entities.*"

In reframing the agricultural subject from the farmer (who, in Jeff's account, controls the system and exhausts its resource) to the gardener (who provides care to cultivate the ecosystem), Jeff practices "return of the surplus," which is one of the core principles in permaculture philosophy, alongside with "care of the earth" and "care of people" [39]—all these values foreground an ethics of care. As prominent care ethicists Fisher and Tronto put it, care is "everything that we do to maintain, continue, and repair 'our world' so that we can live in it as well as possible. That world includes our bodies, ourselves, and our environment, all of which we seek to interweave in a complex, life-sustaining web" [54]. In this sense, the act of care highlights the responsibility to attend to the needs of the others, the interdependency between different entities in the world, and the consequences of such doings [46,47].

Sociologist and feminist STS scholar Maria Puig de la Bellacasa argues that recognizing the "interweaving" relationship between humans and the non-human world helps push the ethics of care from a moral disposition to a quest of searching for alternatives [46]. Returning to the research discourse of sustainable HCI, we see that however diverse its approaches may be, the field increasingly focuses on identifying alternative models, frameworks, and practices, and care ethics informed by permaculture could be one such alternative. As Puig de la Bellacasa writes [46],

> [I]f care *is* a form of relationship it also *creates* relationality. In that sense, as permaculture care ethics consider, humans are not the only ones caring *for* the earth and its beings – we are *in* relations of mutual care. Many nonhuman agencies are taking care of many human needs, as much as humans have their own tasks in the maintenance of the web of caring. (p.163, emphasis in the original).

We might read Jeff and Sophia's act of intentionally leaving rice in the field to feed birds as an instrumental decision—a belief that only by returning the surplus, we can maintain an environment sustainable and keep the resources unexhausted. Embedded in this rationale is not so much about how we react or control to the natural environment but that "we are nature working" [50, p.9], and that our "personal actions have consequences for more than ourselves and our kin" [43, p.160]. Here, working *with* nature means *providing care*, which requires humans to engage in appropriate actions in order to maintain, continue, and repair the interdependent world. Jeff and Sophia enact the ethics of care through *doing*—an everyday and ordinary task of returning the surplus in the form of designing and fabricating the bamboo racks to house the straw for birds to feed on grains. Caring for birds is not a given: becoming able of a "caring obligation" towards the non-human [41] is actively cultivated and nurtured by Jeff and Sophia's hands on bamboo, metal tubes, cotton ropes, rice straws, and their attention and love for the needs of an "other."

5 CONCLUDING DISCUSSION

Developing from a criticism of uncontrolled industrialization and thoughtless urbanization, sustainable HCI focuses on the pursuit of more sustainable alternatives. An initial framing in HCI was to develop computational tools to inform and persuade as an approach to sustainability: tracking user behavior, monitoring and maximizing energy efficiency, as well as persuading and supporting behavior change. This framing depends on the notions of control and correction. While there *is* a need for the community to tackle and harvest the potential of persuasive technology, we, in line with many others, believe this concentration also narrows and impedes what sustainable HCI and do as a community [e.g., 8,13,17,35,46]. Followed by the provocation of considering "the context of broader sociocultural practices" [10], we ground our work in actual farming activities to investigate the goal of sustainability. In this paper, we have provided detailed description to our field sites to contribute towards an alternative framing of sustainable HCI. Our intention is not to correct but to surface the limits of the current control model; similarly, we do not attempt to provide an exhaustive solution but to offer a different perspective to engage in sustainable HCI.

We argue that the control model (one that maximizes labor efficiency) puts humans outside of ecology, managing it as if it were an object under human management. In contrast, the permaculture model (one that maintains, repairs, or improves the natural conditions we are living in) places humans into the ecology as actors but not controllers. To bring this work to a close, we focus on three issues that became visible as a result of this work: distinguishing between human agency and control, managing the risks of pursuing alternative paradigms, and acknowledging that command and control often has aesthetic appeals that attract us giving our counterproductive predispositions toward them and their alternatives.

Intuitively, critiquing the command and control paradigm appears to place human intentionality and agency under suspicion. After all, when we act intentionally within a situation to achieve a certain outcome, there appears to be some sort of effort to control that situation. Thus, the tea farmer who uses bugs

to injure his plants in order to produce a honey taste appears to be exerting control over the situation. Yet if we don't allow that, it seems that we are arguing that humans should abdicate intentional action. To resolve this apparent dilemma, we qualify the concept of human agency. In the control paradigm, human agency controls a situation to the point of domination: little happens in factory farming that the farmer is not aware of and controlling. In permaculture, farmers are still actors, with intentions, rationality, and power, but they don't attempt to eliminate every variable and control every situation. They cede overall control to natural processes but insert themselves into a productive way, which as we saw was shaped by a commitment to *cultivation instead of control* (e.g., tea producers "synchroniz[ing] the rhythms of human labor and its attendant social formations with those of the non-human world" [53, p.56] and to the *provision of care* (e.g., "returning the surplus").

Research into permaculture agriculture not only reveals abstract values but also how they are concretized and performed as embodied practices. The farmers' manifestations of their values in everyday practice reveal particulars that have the potential to inspire and inform HCI. For example, these farms share certain qualities, which might individually and collectively transfer to other domains, such as HCI. One quality is that a lot of this work is viewed as, and pursued as, an experiment or series of experiments. In Yilan, for example, many of the permaculture farmers are collocated and update each other, finding strength in groups. Many of them are only half farmers, further minimizing their personal economic risks. Many are wealthy in the first place, with successful careers as big city architects or Panasonic managers supporting their farming experiments. Each of these qualities foreground another quality of what we witnessed: it is risky.

The risk is that permaculture will fail as a form of commercial farming, that it works fine as the hobby of a relatively well-off couple, but that it will never be able to economically produce food to feed a population. We don't know yet if that will be the case, but the point is that this practice is risky, and working collectively, doing so from a position of economic security, and/or supplementing farming with a separate income all help mitigate that risk. The risk of experimenting with alternative forms of farming also surfaces a limit of this work: that permaculture has yet to demonstrate that it is as an economically sustainable style of farming; for now, at least in Yuanshan township, these practices are best characterized as a lifestyle and agricultural experiment. To address this issue, a role for researchers can be to help evaluate and mitigate such risks, as well as to help make a case that governments and charitable organizations is to help take on that risk themselves.

We believe the risk-taking is worthwhile, however, and not just because of the prospect that permaculture might work, completely or even partially. Another reason is that it creates openings for other surprises. The insects that seemingly ruined the tea leaves created not only a new flavor, but a new product and a new kind of tea connoisseurship. Analogously, the "farm hackers" (those who bring an ethos of open source hacking and making to farming) create surprising hybrid practices that have their own potentials. Once caring becomes automated and habitual, the possibilities for reciprocal benefit open up.

Finally, we offer a reflection on one of our own reactions from visiting these locations. Visiting a tea farm in the mountains of Taiwan evokes images of striking vistas, of elegant rows of plants against the sweeping backdrop of steep mountains. We sometimes see photos of such scenes on travel posters or National Geographic covers. But our initial (if we are honest) reaction to many of these farms was one of disappointment: they seemed so smaller and messier than we had pictured them. This helped us become more sensitized to the beauty in some aspects of industrial agriculture: the structure and order of fields, with identical plants growing in neatly spaced rows, with no weeds or other blemishes on their geometry; or a hillside with hundreds of fuzzy white sheep, munching on a perfectly kept lawn. In contrast, the permaculture farms we visited were visually messy and rather small. They appeared as though they would benefit from a thorough clean-up, suggesting that they seemed "dirty" to us in some way.

The control model taps into and reproduces an aesthetics of order. Not only does the publicly visible side of industrial agriculture appeal to our awareness of the need to feed human populations, but it also looks beautiful. This is also why some aspects of industrial agriculture are kept hidden: in their cruelty and/or filth, they are ugly. Permaculture's beauty requires a different way of looking, which in turn will presumably require the cultivation of public tastes—no small matter.

Another limit of the present work is that the translation of the agricultural concept of "working *with* nature" model into HCI is not straightforward. Further research is needed to work out diverse ways that working with nature can shape HCI and interaction design methodologies. We believe that many studies and experiments will be needed to flesh out what a permaculture-style alternative to HCI's command and control paradigms of sustainability might look like; this paper is but one piece of that greater whole. But in addition to showing that alternative values are viable—by investigating situations where they appear to be successfully working—we also hope to shed light on the conditions of those situations. They do require human agency and action, but qualified in ways that reflect a sort of submission to natural processes and care for other actors in those processes. They also unfold through experimentation, which entails risks that are not best borne by individuals. And finally, they reflect alternative aesthetic sensibilities, a taste for certain kinds of forms, and an affinity for certain kinds of meanings—which many of us understandably lack.

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REFERENCES

[1] Alloun, E. and Alexander, S. *The Transition Movement: Questions of Diversity, Power, and Affluence*. Melbourne, 2014.

[2] Bardzell, S. (2018, to appear). Utopias of Participation: Feminism, Design, and the Futures. *ACM Transactions on Computer-Human Interaction (TOCHI)*, .

[3] Bardzell, S., Bardzell, J., and Ng, S. Supporting Cultures of Making: Technology, Policy, Visions , and Myths. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, (2017), 6523–6535.

[4] Bardzell, S., Rosner, D., and Bardzell, J. Crafting quality in design: integrity, creativity, and public sensibility. *Proceedings of the Designing Interactive Systems Conference*, (2012), 11–20.

[5] Bay, U. Transition Town Initiatives Promoting Transformational Community Change In Tackling Peak Oil And Climate Change Challenges. *Australian Social Work 66*, 2 (2013), 171–186.

[6] Bell, G. *The Permaculture Way: Practical Steps to Create a Self-Sustaining World*. Harper Collins Publishers, London, 1992.

[7] Blevis, E. Sustainable Interaction Design: Invention & Disposal, Renewal & Reuse. *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '07*, (2007), 503.

[8] Blevis, E. and Morse, S.C. Food, Dude. *Interactions*, 2009, 58–62.

[9] Bourgeois, J., Linden, J. Van Der, Kortuem, G., et al. Conversations with my washing machine: an in-the-wild study of demand-shifting with self-generated energy. *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing - UbiComp '14 Adjunct*, (2014), 459–470.

[10] Brynjarsdottir, H., Håkansson, M., Pierce, J., Baumer, E., DiSalvo, C., and Sengers, P. Sustainably unpersuaded: How Persuasion Narrows Our Vision of Sustainability. *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*, (2012), 947–956.

[11] Chang, S.E. Blue Magpie TEAgriculture: Eco-tea Cultivation and Participatory Farming in Pinglin Satoyama, Taiwan. *Procedia - Social and Behavioral Sciences 101*, (2013), 14–22.

[12] Chiang, Y.-C. A Study of Inheriting Local Knowledge on Long-Tan Pong-Feng Tea Culture. 2010.

[13] Comber, R. and Thieme, A. Designing beyond habit: Opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect. *Personal and Ubiquitous Computing 17*, 6 (2013), 1197–1210.

[14] Costanza, E., Ramchurn, S.D., and Jennings, N.R. Understanding domestic energy consumption through interactive visualisation: a field study. *Proceedings of the 2012 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp '12)*, (2012), 216–225.

[15] DiSalvo, C., Sengers, P., and Brynjarsdóttir, H. Mapping the landscape of sustainable HCI. *Proceedings of the 28th international conference on Human factors in computing systems - CHI '10*, (2010), 1975–1984.

[16] Dourish, P. HCI and environmental sustainability: the politics of design and the design of politics. *Proceedings of the 8th ACM Conference on Designing Interactive Systems . ACM.*, (2010), 1–10.

[17] Egan, C. and Benyon, D. Sustainable HCI: Blending Permaculture and User-experience. *DIS '17 Companion*, (2017), 39–43.

[18] Entwistle, J.M., Rasmussen, M.K., Verdezoto, N., Brewer, R.S., and Andersen, M.S. Beyond the Individual: The Contextual Wheel of Practice As a Research Framework for Sustainable HCI. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, (2015), 1125–1134.

[19] Eriksson, E., Pargman, D., Bates, O., et al. HCI and UN's Sustainable Development Goals. *Proceedings of the 9th Nordic Conference on Human-Computer Interaction - NordiCHI '16*, (2016), 1–2.

[20] Fogg, B.J. Creating Persuasive Technologies: An Eight-Step Design Process. *Persuasive '09 Proceedings of the 4th International Conference on Persuasive Technology*, (2009), 1–6.

[21] Foster, D., Blythe, M., Cairns, P., and Lawson, S. Competitive Carbon counting: Can Social Networking Sites Make Saving Energy More Enjoyable? *Proceedings of the 28th of the international conference extended abstracts on Human factors in computing systems - CHI EA '10*, (2010), 4039.

[22] Freeman, G., Bardzell, J., and Bardzell, S. Aspirational design and messy democracy: Partisanship, policy, and hope in an Asian city. *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*, (2017), 404–416.

[23] Freeman, G., Bardzell, S., and Bardzell, J. Bottom-Up Imaginaries: The Cultural - Technical Practice of Inventing Regional Advantage through IT R&D. *CHI '18*, (2018).

[24] Gui, X. and Nardi, B. Foster the 'mores', counter the 'limits.' *First Monday 20*, 8 (2015).

[25] Hasselqvist, H., Bogdan, C., and Kis, F. Linking Data to Action: Designing for Amateur Energy Management. *Proceedings of the 2016 ACM Conference on Designing Interactive Systems - DIS '16*, (2016), 473–483.

[26] Hasselqvist, H., Hesselgren, M., and Bogdan, C. Challenging the Car Norm: Opportunities for ICT to Support Sustainable Transportation Practices. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*, (2016), 1300–1311.

[27] Hathaway, M.D. Agroecology and permaculture: addressing key ecological problems by rethinking and redesigning agricultural systems. *Journal of Environmental Studies and Sciences 6*, 2 (2016), 239–250.

[28] Heitlinger, S., Bryan-Kinns, N., and Jefferies, J. Sustainable HCI for grassroots urban food-growing communities. *Proceedings of the 25th Australian Computer-Human Interaction Conference - OzCHI '13*, (2013), 255–264.

[29] Hirsch, T., Sengers, P., Blevis, E., Beckwith, R., and Parikh, T. Making Food, Producing Sustainability. *Proceedings of the 28th of the international conference extended abstracts on Human factors in computing systems - CHI EA '10*, (2010), 3147.

[30] Holmgren, D. *Permaculture: Principles & Pathways Beyond Sustainability*. Permanent Publications, 2011.

[31] Huang, S. and Kuo, D. Premier looks at 'green' aspects of Pinglin township. *Focus Taiwan*, 2010. http://focustaiwan.tw/news/aliv/201006270016.aspx.

[32] Kjeldskov, J., Skov, M.B., Paay, J., Lund, D., Madsen, T., and Nielsen, M. Eco-Forecasting for Domestic Electricity Use. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems - CHI '15*, (2015), 1985–1988.

[33] Knowles, B. and Håkansson, M. A Sustainable HCI Knowledge Base in Progress. *Interactions*, 2016, 74–76.

[34] Lindtner, S., Bardzell, S., and Bardzell, J. Reconstituting the Utopian Vision of Making: HCI After Technosolutionism. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*, May (2016), 1390–1402.

[35] Mankoff, J.C., Blevis, E., Borning, A., et al. Environmental sustainability and interaction. *CHI '07 extended abstracts on Human factors in computing systems - CHI '07*, (2007), 2121.

[36] Mauriello, M.L., Saha, M., Brown, E., and Froehlich, J.E. Exploring Novice Approaches to Smartphone-based Thermographic Energy Auditing. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*, (2017), 1768–1780.

[37] Meurer, J., Lawo, D., Janßen, L., and Wulf, V. Designing Mobility Eco-Feedback for Elderly Users. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '16*, (2016), 921–926.

[38] Møllenbach, E. and Hoff, J. HCI and Sustainability: The Role of Macrostructures. *CHI'12 EA*, (2012), 2159–2164.

[39] Mollison, B. *Permaculture: A Designers' Manual*. Tagari Publications, Tasmania, Australia, 1988.

[40] Mollison, B. and Holmgren, D. *Permaculture One: A Perennial Agriculture for Human Settlements*. Transworld Publishers, 1978.

[41] Petkov, P., Köbler, F., Foth, M., Medland, R., and Krcmar, H. Engaging energy saving through motivation-specific social comparison. *Proceedings of the 2011 annual conference extended abstracts on Human factors in computing systems - CHI EA '11*, (2011), 1945.

[42] Pierce, J. and Paulos, E. Beyond energy monitors: interaction, energy, and emerging energy systems. *CHI '12: Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems*, (2012), 1–10.

[43] Pierce, J., Schiano, D.J., and Paulos, E. Home, Habits and Energy: Examining Domestic Interactions and Energy Consumption. *CHI '10 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, (2010), 1985–1994.

[44] Preist, C., Busse, D.K., Nathan, L.P., and Mann, S. POST-SUSTAINABILITY: A CHI Sustainability Community Workshop. *CHI'12 EA*, (2013), 3251–3254.

[45] Prost, S., Schrammel, J., and Tscheligi, M. 'Sometimes it's the weather's fault': sustainable HCI & political activism. *Proceedings of the extended abstracts of the 32nd annual ACM conference on Human factors in computing systems - CHI EA '14*, (2014), 2005–2010.

[46] Puig de la Bellacasa, M. Ethical doings in naturecultures. *Ethics, Place and Environment 13*, 2 (2010), 151–169.

[47] Puig de la Bellacasa, M. Matters of care in technoscience: Assembling neglected things. *Social Studies of Science 41*, 1 (2011), 85–106.

[48] Raghavan, B., Nardi, B., Lovell, S.T., Norton, J., Tomlinson, B., and Patterson, D.J. Computational Agroecology: Sustainable Food Ecosystem Design. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, (2016), 423–435.

[49] Raghavan, B. and Pargman, D. Means and Ends in Human-Computer Interaction. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, (2017), 786–796.

[50] Rasmussen, M.K., Rasmussen, M.K., Verdezoto, N., Brewer, R., Nielsen, L.L., and Bouvin, N.O. Exploring the Flexibility of Everyday Practices for Shifting Energy Consumption through ClockCast. *Proceedings of the 29th*

Australian Conference on Computer-Human Interaction, (2017), 296–306.
[51] Sakata, K. Studies on aroma formation mechanisms during tea manufacturing suggest methods not only to improve the quality of made teas , but also to produce new types of teas. *The Internatinal Conference on O-CHA(Tea) Culture and Science*, (2010).
[52] Scott, E. Oriental Beauty and Other Bug-Bitten Teas: Fact or Fiction ? *World of Tea*, 2016. https://worldoftea.org/oriental-beauty-bug-bitten-teas/.
[53] Starhawk. *The Earth Path: Grounding Your Spirit in the Rhythms of Nature*. HarperOne, San Francisco, 2004.
[54] Tronto, J.C. and Fisher, B. Toward a Feminist Theory of Caring. In E.K. Abel and M.K. Nelson, eds., *Circles of Care: Work and Identity in Women's Lives*. SUNY Press, Albany, NY, 1990, 36–54.
[55] Woodruff, A. and Mankoff, J. Environmental Sustainability. *IEEE CS*, (2009), 18–21.
[56] Writer, S. "Relying on Heaven": Natural Farming and "Eco-tea" in Taiwan. In T. Lewis, ed., *Green Asia: Ecocultures, Sustainable Lifestyles, and Ethical Consumption*. Taylor & Francis, 2016, 51–65.
[57] Yang, R., Pisharoty, D., Montazeri, S., Whitehouse, K., and Newman, M.W. How does eco-coaching help to save energy? assessing a recommendation system for energy-efficient thermostat scheduling. *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing - UbiComp '16*, (2016), 1176–1187.
[58] Yun, R., Aziz, A., Scupelli, P., Lasternas, B., Zhang, C., and Loftness, V. Beyond Eco-Feedback: Adding Online Manual and Automated Controls to Promote Workplace Sustainability. *Proceedings of the ACM CHI'15 Conference on Human Factors in Computing Systems*, (2015), 1989–1992.
[59] Zapico, J.L., Katzeff, C., Bohné, U., and Milestad, R. Eco-feedback Visualization for Closing the Gap of Organic Food Consumption. *Proceedings of the 9th Nordic Conference on Human-Computer Interaction - NordiCHI '16*, (2016), 1–9.
[60] 吳聲舜. 蜜香茶的秘密. *農政與農情*, (2016).
[61] 廖靜蕙. 吸一口更甘甜！與小綠葉蟬共生 蜜香紅茶傳頌國際. *Taiwan Environmental Information Center*, 2015. http://e-info.org.tw/node/110325.
[62] 新北市政府農業局. 青蛙王子拚復育 有機茶園鮮體驗. *新北市政府*, 2017. https://www.ntpc.gov.tw/ch/home.jsp?id=28&parentpath=0,1944&mcustomize=news_view.jsp&dataserno=201711300005&t=null&mserno=201309100001.
[63] 翁崧夏. 親密關係—東方美人茶與茶小綠葉蟬. *Agricultural Extension Newletter, College of Bio-Resources and Agriculture, National Taiwan University*, 2012, 12–15. http://www.bioagri.ntu.edu.tw/extcom/sub_title/public/data/ntuaeN/ntuaeN_No_095.pdf.
[64] 黃仲杰. 推動友善環境農業. *農政與農情*, 2016. https://www.coa.gov.tw/ws.php?id=2505838.
[65] What is Permaculture. *Permaculture Research Institute*. https://permaculturenews.org/what-is-permaculture/.
[66] About Tse-Xin Organic Agriculture Foundation (TOAF). *Tse-Xin Organic Agriculture Foundation*. http://toaf.org.tw/en.
[67] About Us. *Taiwan Bluemagpie Tea*. http://bluemagpietea.com/index.php/en/.
[68] Introduction to the Towns. *Yilan County Government*. http://enwww.e-land.gov.tw/cp.aspx?n=DE11525F5E6F3240&s=CBD60B9DF9717A4A.
[69] Dongfang Meiren. *Wikipedia*. https://en.wikipedia.org/wiki/Dongfang_Meiren.
[70] Why Do Farmers Burn? *Manitoba*. https://www.gov.mb.ca/agriculture/crops/crop-residue-burning-program/why-do-farmers-burn.html.