Negotiating Food Waste: Using a Practice Lens to Inform Design

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Ecological sustainability is becoming of increasing concern to the HCI community, though little focus has been given yet to issues around food waste. Given the environmental impact of food waste, there is potential to make a significant difference. To understand everyday domestic practices around food and waste, we took a "practice" lens and carried out a study in 14 households that involved interviews, in-home tours and, in five of the households, a FridgeCam technology probe. The analysis highlights that food waste is the unintended result of multiple moments of consumption dispersed in space and time across other integrated practices such as shopping and cooking, which are themselves embedded in broader contextual factors and values. We highlight the importance of respecting the complex negotiations that people make within given structural conditions and competing values and practices, and suggest design strategies to support dispersed as well as integrated food practices, rather than focusing on waste itself.

1. INTRODUCTION

Issues of ecological sustainability are becoming of increasing concern worldwide and this is paralleled by a growing interest in HCI to support more sustainable practice [DiSalvo et al. 2010]. To date this has largely played out in relation to energy consumption [Fitzpatrick and Smith 2009] or transportation choices [Froehlich et al. 2010]. However, food is another area of growing concern for ecological sustainability, especially considering an increasing population and its demand for both food consumption and production [Cuellar and Webber 2010; Gustavsson et al. 2011]. What is produced, what we eat, and how much of the food is thrown away in production and consumption greatly affect greenhouse gas emissions, which in turn will have almost unpredictable impacts on our climate, fauna, and flora [IPCC 2007].

Sustainability in relation to food can be considered around three main issues. First an animal-based diet causes more greenhouse gas emissions compared to a more plant-based diet [Eshel and Martin 2006]. Second, organic farming, and associated

organic food consumption, has very positive effects on the environment and on public health [Pimentel et al. 2005]. Organic food consumption, while often coupled to a regional and seasonal emphasis supporting community values, does not necessarily entail less resource-intensive farming methods [Weber and Matthews 2008]. On the other hand, a local and seasonal diet supports local business, regional food cultures, and food security [Kaiser 2011]. Third, and the key motivation for our article here, is the environmental impact of food waste [Hall et al. 2009]. According to a study in the U.S.A. approximately 27% of edible food is wasted, which is equivalent to 2% of the annual energy consumption [Cuellar and Webber 2010]. A study in the UK revealed that up to 30% of food waste is wasted by consumers at home rather than in agriculture or retail [Ambler-Edwards et al. 2009]. Another study from the United Nations investigated food waste more globally and presents similar results, indicating that one-third of the total worldwide food production and consumption is thrown away [Gustavsson et al. 2011]. According to a study in Austria, food in residual waste amounts up to 13% [Schneider and Lebersorger 2009]. Hence food waste, for example, through overbuying or letting food spoil, unnecessarily contributes to greenhouse gas emissions, which could be easily avoided if we produced and consumed just the food that is needed.

The focus of this article is on understanding everyday practices, using a "theory of practice" lens [Reckwitz 2002], around food and waste from the consumer/household perspective. To this end we report on a qualitative study with 14 households that involved 17 participants, using a combination of in-home interviews and tours. This was followed up with an additional technology probe study with 5 of the 14 households using a FridgeCam in the home. Findings point to the impact of food waste as an unintended consequence arising out of multiple moments of previous consumption, dispersed across space and time in everyday integrated practices such as shopping, storing, gardening, or cooking. We further report on the role of positive or negative strategies for food waste and how participants negotiate between wanting to avoid food waste and other competing needs and practices. The main contribution of this article is to highlight the sensitive ethical stance we need to take as designers in respecting the choices that people make in the face of these in-the-moment negotiations. Rather than focus design interventions on the waste itself from a moralistic stance, a better focus can be on supporting choices in those previous moments of consumption, respecting that no one actually intends to waste. We propose a set of design strategies that seek to: increase awareness and opportunities for reflection, especially around dispersed practices; and provide practical support for decision making and action as part of integrated practices.

2. BACKGROUND AND RELATED WORK

Food waste is tied up with the larger picture around food practices more generally. Food and sustainability have both received attention in diverse literatures. Here we draw on two broad areas: psychology and sociology research and some of the main issues they identify around sustainable food practices; and HCI research and how HCI has approached support for sustainability and food more generally.

2.1. From Food and the Individual to Society

The literature in (social) psychology and sociology points to issues around food and sustainability being complex and multifactorial.

> Food is a cultural and social concept, what constitutes food is determined by the social and cultural milieu of the potential consumer [Belton and Belton 2002, page 1].

This social and cultural milieu includes external factors such as the food itself, for example, its nutrient content, time, space, and social context as well as by

internal factors specific to the individual [Belton and Belton 2002], for example, sensory, psychological, and physiological factors which can influence food choices and intake [Conner and Armitage 2002]. Food practices are also influenced by the socio-demographic background through which we develop our life history and the orientation of our norms, values, attitudes, and expertise [Brunner et al. 2007]. Food is also identified as being inherently social. Cooking and/or eating are activities that connect family members or let friends have a great time together [Grimes and Harper 2008]. Food is also involved in orchestrating matters of self-presentation as we are judged and judge others on the food bought and eaten [Conner and Armitage 2002].

In relation to sustainable behavior around food, several factors have been identified as having a positive influence, namely higher education, availability, price, female gender, gardening, and growing up in a family that already has a lifestyle towards sustainability [Brunner et al. 2007]. However, even if values, intentions, and attitudes are positive towards sustainable food consumption and disposal, it does not imply that this is always reflected in everyday practice. Vermeir and Vebeke [2006] call this the intention-behavior gap. To try to explore the factors that are more implicated in this gap, Vermeir and Vebeke [2006] conducted a laboratory study of purchase of sustainable food products, and suggest a number of factors that can foster consumption decisions towards organic products, in line with people's intentions. These include: involvement with sustainability, perceived availability, and perceived consumer effectiveness. However, as the study was carried out in controlled conditions and not in the field, it doesn't capture the whole experience or process people undergo when buying at a food retailer and other situations of practice where this intention-behavior gap plays out around food.

In summary, while these studies point out the various factors and influences at a macro level it isn't clear how they practically translate into the routine of everyday practices and choices people make around food or how we might interpret these factors in designing support for sustainability. In the work to be reported on here, we take the social context around food as given and focus in the first instance on the practices of individuals. Within these social contexts and the broader social and cultural milieu, we want to understand the more mundane practices around food getting into and being used, or not, in the home.

2.2. Sustainability, Food and HCI

Food practices and ecological sustainability have started to gain some attention in HCI and are often described in terms of supporting local and alternative movements and communities. These could be, for example, interactive technologies for small-scale food producers [Light et al. 2010], farmers' markets [Odom 2010], food co-ops, urban gardens, locavorism[1], freeganism[2], permaculture, or slow food communities. Blevis and Morse [2009] suggest a number of ways in which alternative food movements could be supported by technologies to promote local food production, more sustainable food consumption, and sustainable land use. Existing practical applications in the area of ecological sustainable food culture often aim to achieve sustainable food purchasing habits, such as providing communities with information about how to buy locally [Li et al. 2009], enhancing the transparency of the supply chain [Bonnani et al. 2010], or supporting information on food miles during shopping [Kalnikaite et al. 2011]. For designing such interactive systems, Choi and Blevis [2010, page 116] argue for the necessity of user participation during the design process and "anticipation for the technology's socio-cultural, health, and environmental impact". However, while food and sustainability are topics of concern in all this work, the focus is more on where

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[1]Term to describe the practice of eating food harvested within an area mostly bound by a 100-mile radius.
[2]The practice of collecting and eating food that has been discarded.

the food comes from and not where it goes to. An exception is the BinCam work of Thieme et al. [2012], a two-part persuasive system where a mobile phone embedded in a kitchen bin uploads images of domestic waste to a Facebook page, enabling reflection on inappropriate waste disposal practices, including the creation of food waste. Other domestic research has looked at "waste" in the home, but in the form of reusing and reacquiring objects in the home [Pierce and Paulos 2011].

Other food-related work in HCI is concerned with promoting healthy eating [Grimes et al. 2008; Maitland and Chalmers 2011] often with an emphasis on choice of foods and on social support. While there are many parallels between an ecologically sustainable diet and a healthy diet, in the sense of motivating "good" individual choices, the problem space around sustainable food consumption may be very different from health-related food issues. The impetus for healthy eating is more likely to be immediately evident to the individual, such as feeling better or losing weight, even if the long-term benefits, for example, reduced risk of various cancers, may be less evident. Sustainable food practices do not typically afford this immediacy, either as a perceived or actual benefit. Even though financial savings can be made, this is typically due to more efficient or reduced food consumption and reduced waste. The issue around costs for the consumers is reflected by a study from WRAP (Waste and Resources Action Program in the UK), who found a reduction of consumer food waste of 13% between 2006/7 and 2010 in households in the UK due to rising food and drink prices and reduced incomes. Still it is estimated that about one-fifth of all food and drink purchases goes to waste [Quested and Parry 2011]. Therefore the perceived benefit of less wasted food for the individual household in this case can be seen in changed shopping patterns and more careful handling of food rather than being motivated by "the greater good" in consuming less.

Sustainability has also been of interest in HCI more generally. Many of the research interventions targeting ecological sustainability and the environment draw from motivational theories to promote behavior change [Consolvo et al. 2009], with energy consumption taking a particular focus [Fitzpatrick and Smith 2009; Froehlich et al. 2010; He et al. 2010]. While the issue of trying to reduce food waste shares the "greater good" aspects of such energy-related research, it is different in the way that direct monetary savings can be achieved by reducing consumption. Food wastage occurs after the monetary investment has already been made at initial purchase. Hence the motivation-reward structures around food waste can be quite different.

Since 30% of food waste is created by consumers at home [Ambler-Edwards et al. 2009], it is reasonable to think of the home as a target domain for HCI interventions around food waste, hence recent "smart home" advances are also of interest here. These include interactive fridges [Bucci et al. 2010], kitchen appliances for energy feedback [Kirman et al. 2010], and fully equipped smart kitchens [Olivier et al. 2009], for example, to enable nutrition, aware cooking [Chi et al. 2007]. These pervasive sensor-based approaches open up new possibilities for supporting practices around food and helping reduce waste.

However, to understand what technologies might be useful and to realize any potential of technology, we first need to understand more about the everyday domestic practices associated with food waste [Evans 2012]. While food and sustainability have been of concern to HCI more generally [Choi and Blevis 2010], an understanding about the specific issue of food waste and technological interventions has yet to be directly addressed.

2.3. Understanding Everyday Practices to Inform Interventions

As previously stated, since most of the food for private consumption is wasted at home and at the consumer level [Ambler-Edwards et al. 2009], we wanted to understand some of the details involved in daily domestic practices around food and waste. In doing so

it is useful to take a "theory of practice" lens [Schatzki 1996]. This lens promotes understanding and interpreting practices using a notion of "practice" as defined by Reckwitz [2002]: the "routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood." [ibid, page 256]. People are neither autonomous in their practices nor are they obeying social norms with total conformity [Reckwitz 2002]. Practice theory can be viewed from different perspectives and for this article we find it beneficial to operate on Schatzki's [1996] differentiation between integrative and dispersed practices, which we will utilize to inform designs later on.

Integrative practices are those most commonly understood and described as practices; the "doing and saying" of a variety of actions in routinized performances in specific contexts; embodied routines that are core to everyday practices [Reckwitz 2002]. Examples related to food would be cooking practices and eating practices, where the embodied actions of the cook or the diner are often habitual, informed by histories and cultures of performance, but also adapted to an unfolding social and environmental context. A cook might, for instance, have a set routine for cooking a specific dish, but can also adapt the performance to particular contexts (e.g., take a longer time preparing a dish if s/he has time to do so). As such an integrative practice does not describe a particular set of actions, but rather the coordination of action in a meaningful process and typically towards a particular goal. Such practices are specific to particular domains. For instance, cooking food at home is different from cooking food in a restaurant.

Dispersed practices, on the other hand, are the "doings and sayings" that occur in different ways in different domains and so are both common to and transcend any particular integrated practice. These practices typically center on a single type of action [Schatzki 1996] such as "describing, ordering, explaining, questioning, reporting, examining, imagining" [ibid, page 91], caring, or being polite. Like integrative practices, they involve the routinized performance of basic doings and sayings, but, unlike integrative practices, they are not guided by rules or particular ways of negotiating performance of the practice. Another example of a dispersed practice is consumption [Warde 2005]. Consumption can involve very different "doings and sayings" in different domains. People "consume" across any number of, and Warde argues all, domains (e.g., consuming food, consuming media, consuming energy resources), often without awareness or reflection, in particular domains (e.g., eating, watching TV, driving). A dispersed practice is enacted in moments of everyday integrated practice and takes different forms in different domains. However, there remains an understanding of these dispersed practices that transcends each domain.

Technologies are also clearly implicated in everyday practices, as part of the "acting" out. Given the environmental impact and contribution of food waste to greenhouse gas emissions, we are motivated by the potential of technology interventions to make a difference and to encourage practices that might result in less food waste. It is important, however, to design such technologies carefully with a view to how they can be incorporated into everyday practices. In this regard, we see similarities between the design of technologies and the design of policies to change practices, where Warde [2005] argues that theories about social practice imply that policies (for us, technologies) have to consider "how are individuals positioned in the practices in which they are engaged?" [ibid, page 149]. To overcome the gap between individual "values" and "actions", the so-called value-action or intention-behavior gap (given that people have a certain intention), "policy [we add technology] must be sensitive to the everyday contexts in which individual intentions and actions are constrained by socioeconomic and political institutions" [Blake 1999, page 274]. Dourish [2010] states similar concerns in advocating an understanding and inquiry into the contexts and practices in which technologies may play a role. For this reason, it becomes critical for us to understand

Table I. Summary Table of Study Participants

Name	Sex	Age	Method	Living	Housing	Social situation
Stephen	m	28	I + HT	City, A	Apartment	Single
William	m	37	I + HT	City, A	Apartment	Single
Hanna	f	29	I + HT	City, A	Apartment	Lives with sister
Sandra	f	24	I + HT	City, A	Apartment	Daughter + husband
Yvonne	f	59	I + HT	Village, A	House + Garden	4 grown up children, husband
Ida	f	34	I + HT	Village, A	Apartment	2 children, husband
Jasmin	f	71	I + HT	Small Town, A	House + Garden	Daughter's family lives above
Anna	f	47	I	Village, A	Farm + Garden	3 sons, husband, mother in law
Wilma Noah	f m	38 42	I + HT I	Small Town, A	House + Garden	3 children + Wilma's husband
Michael	m	57	I +HT + FC	City, UK	House + backyard	Lives with landlady and another lodger
Victor	m	24	I +HT + FC	City, UK	House + backyard	Lives with 2 other flat mates
Rose Maria	f f	24 24	I +HT + FC	City, UK	House + backyard	Both single, live together in a household
Susanna	f	29	I +HT + FC	City, A	Apartment	Has a boyfriend, lives alone in a household
Philip Frank	m m	31 26	I +HT + FC	City, A	Apartment	Both single, live together in a household.

(I = Interview; HT = home tour, FC = FridgeCam, A = Austria, UK = United Kingdom).

what are the everyday practices around food and how these are implicated or not in food waste to in turn be able to design interventions.

We go on now to describe the studies and use this practice lens and the understandings gained to identify opportunities for the design of technologies to support more ecologically-aware food practices and the reduction of food waste.

3. PARTICIPANT AND FIELD STUDY METHOD

Two studies were conducted to gather qualitative data about practices around food and food waste: in-home interviews combined with home tours; and in-home one-month deployments of a FridgeCam probe. For the in-home interviews and home tours, we recruited 17 participants in 14 households (i.e., three of the households involved two participants each). The study design was reviewed and approved by a university's ethics committee. As this is an initial study to identify broad practices, we used an opportunistic sampling method through the authors' extended social networks; this resulted in 11 households in Austria and 3 in the UK. For this round, we focused on target participants who were mainly responsible for organizing and carrying out the shopping and cooking, rather than including all members of a household. Table I provides a summary of the participants, referred to by pseudonyms. Participants varied regarding education, family status, household income, age, gender, ecological attitude, urban or rural living environments, and cultural backgrounds. Dwellings varied as well, and included apartments, residential houses, and single-family dwellings. In taking such an opportunistic approach in the first instance, we were aiming for breadth and diversity, without any claims to representativeness along cultural or other dimensions. This served to sensitize us to a range of different practices that might be invisible in more homogenous cohorts.

Fig. 1. FridgeCam system attached to the door (left) and picture of the inside of the fridge taken by the camera (right).

The semistructured in-depth interviews with home tours followed a similar qualitative methodology to other in-home research [Pierce and Paulos 2011; Strengers 2011; Stringer et al. 2006; Woodruff et al. 2008]. For the interviews, an interview protocol was developed covering the following broad themes, while also leaving the interviewer free to follow leads as they emerged in conversation.

—We include aspects that motivate choices around food, such as price, region, season, proximity of food retailer, etc.
—We also cover the process of planning, shopping, buying, producing, storing, cooking, eating, and throwing away foods in daily practice, with a particular emphasis on ways of storing and organizing food.
—We focus on reasons why foods spoil, why they are wasted, identifying the strategies participants use to avoid this and how people perceive food waste itself.

We also asked participants to take us on a home tour and show us where and how they store their food, during which we also took photos. All but one of the households agreed to the home tour with photos. After gaining a general empirical understanding of everyday practices connected to food and food waste, we prototyped an intervention, FridgeCam (see Figure 1) to be used as a technology probe [Hutchinson et al. 2003; Arnold 2004]. The aim in this study was to stimulate further reflections around food and waste, as well as open up discussions about a possible role for technology, recognizing that the fridge plays an important role in the storage of fresh food in the home.

Technically, FridgeCam is a mobile phone attached to the inside of a refrigerator or "fridge" door (see Figure 1, left). For every second that the fridge door is opened the accelerometer sensor in the phone triggers the camera in the phone to take pictures through an attached fisheye lens (see Figure 1, right) and uploads it to a dedicated Web page on a FridgeCam domain. Users can access the latest 15 captured images through their smart phones or computers. We were curious to see whether participants would
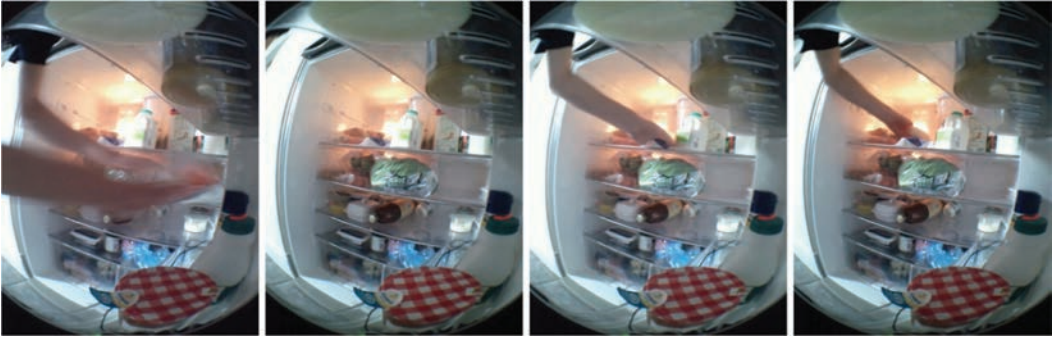
Fig. 2. Successive images from FridgeCam, showing changes in the fridge as it is used. Participants were shown a time-lapse video of all images captured from their fridges.

access the images and whether these would prompt further reflections on everyday food practices through seeing the contents of their fridge. We were also curious to see whether they would proactively seek out FridgeCam images when planning for shopping.

The FridgeCam system was deployed in five of our participant households for one month: three households in Newcastle, UK, and two households in Vienna, Austria. Here there was more uniformity among the households than in the first study, with all being households involving singles and who were familiar with smart phone use. The FridgeCam was installed directly after the in-home interview and tour. Participants were given no instructions other than a technical sheet with the link to the Web site and instructions in case of technical problems. Participants were told to use FridgeCam as they desired.

During the one-month study period participants were contacted twice via email or personal visit to elicit reports on their experiences so far. Web site traffic was also captured using Google[TM] Analytics[3], to track visits from countries and mobile versus non-mobile browsers. This data was captured at the total domain level not broken down to specific FridgeCam pages. At the end of the month, in-home closing interviews were conducted, exploring questions around technology use, experiences with FridgeCam, and situations when the FridgeCam Web site was looked up. We also created time-lapse videos (see Figure 2), from all the pictures taken for every household and watched these videos together with participants to facilitate reflection and discussion.

Data was collected via audio recording of the interviews and via photos taken during the home tour. Emails reporting on experiences and use were collected from the FridgeCam study, along with logs of all images uploaded to the Web. The interview data was transcribed and analyzed by the authors using an inductive thematic analysis [Braun and Clarke 2006] approach where codes emerged from the material and were not defined a priori. Data and codes were then captured in TAMS Analyzer[4], an open-source qualitative research tool.

In presenting this data, please note that the direct participant quotes from Austrian participants have been translated from colloquial German into English to make it understandable for an international audience. The participants did not receive any remuneration for their participation.

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[3]http://www.google.com/analytics/.

[4]http://tamsys.sourceforge.net/.

4. FINDINGS

All of the participants were concerned about food waste; none liked wasting food and some appeared to feel guilty when reflecting on the food they threw away: "*it hurts me but it happens nonetheless*" (William), issues also found by Thieme et al. [2012] and [Evans 2012]. Only two participants identified themselves though as being "eco-warriors", that is, motivated and engaged in sustainable discourses and practices (William as a vegetarian and Greenpeace activist climber, and Anna as an organic farmer with a strong emphasis on regionalism). Discussions revealed other underlying values. One was around ethical issues "because people are hungry in the world" (Victor) and participants referred to them as social norms being taught when they were children: "It's just the way I was brought up. You eat what was on your plate. And if you don't, you eat it tomorrow." (Michael). Michael also told the story of his mother who was brought up in a big family during World War II, experiences that formed her attitude to food as something that had to be treated mindfully and frugally. Others mentioned the waste of money that happened along with waste of food: "And then a month later it is gone off and you are like 'That was a waste of money'" (Maria). Hence, costs and ethical values like hunger or the value of food were more prominent than the sustainable implications of food waste for our participants, which suggests that this is still a topic to be discussed for public awareness.

Against this broad understanding of the participants' stances around food waste, we go on now to discuss the findings from the perspective of everyday food practices at the home in the context of sustainability. We organize this discussion around the broad themes of integrated practices such as shopping, gardening, storing, and specific practices around food waste. The data highlights that while almost all of our participants wanted to engage in sustainable food practice in some way as indicated earlier, people often experience a gap between what they want to and what they actually do in everyday life, as also reported in the literature [Vermeir and Vebeke 2006]. The data we present here points to some of the complex and intertwined tensions within and between practices around this intention-behavior gap.

4.1. Shopping

Shopping is a critical integrated practice in modern societies as a routine means of getting food into the home. How this shopping happened, though, varied across our participants and highlights the ways in which routines of shopping are intertwined with a range of other concerns.

4.1.1. Shopping Planning. Planning, or lack there of, is one issue that can have later implications for food waste. Our participants reported a variety of strategies around shopping planning. Around half of our participants used shopping lists to think about what they needed to buy. To do their planning, these participants reported that they looked in the fridge and other places where they stored foods at their homes and created their lists before going shopping. The relation of these lists to what was actually bought varied, however. For some participants, the list was important for managing the efficiency and experience of shopping:

> "[with a list] I simply go there [to the supermarket] and I don't have to think about it, because when I realize that something is not here I write it onto my shopping list. I go there, shop for it and go home again, because I hate shopping, shopping for me is something really stressful." (William)

"At the weekend I go shopping more consciously, and then with a shopping list." (Susanna)

Nonetheless, both also reported buying more than what is on their list: Susanna continued to say: "[. . .] though I often buy more than what is on the list" (Susanna).

And William, at a later point in the interview, also conceded: "Sometimes it happens that I see things there that I didn't think of before, things that I desire at the moment, for example a cup of ice-cream, this happens sometimes." (William)

So one of the main motivations claimed by participants for using lists was not so much to avoid buying more than they needed but as a reminder. "I don't want to come back and say 'Oh I should have bought this or should have bought that.' Or I have forgotten it. [. . .] [a list] is quite good for knowing, just getting exactly what you want." (Maria)

However, despite the recognition by many participants that lists were helpful, not everyone used lists. Ida, for whom shopping was something she did almost daily as mother, housewife, and part-time occupational therapist, explained: "It sometimes happens, because I don't have a list, that I forget the one thing or the other. Or that I buy something that was already in the fridge and I was thinking is not there."

The reasons for not using lists were often to do with time pressures. For example, when their lifestyles were very busy with work and/or leisure time, they often didn't have (or make) time to have a look at the fridge in advance of going shopping. Commonly too, participants often shopped opportunistically, for example, going shopping after work when they could, but without remembering details of what was at home. This was the case for Wilma: "well you never know what there is exactly in the fridge. So shopping is nothing that is a planned act. If there is time after work one grabs something." "Not knowing" was further complicated in this household by the fact that both Wilma and her husband worked full time. They shared the shopping activities but without any strong coordination and sometimes both went shopping on the way home from work, so they doubled up, or neither went shopping, expecting the other to do so.

Planning, however, did not always turn out as expected or result in less waste for many participants. A key factor in this was the unpredictability of their lives. This was particularly so for the single participants who often ended up spontaneously going out in response to calls from friends. Hence they were unable to accurately predict or plan when they would be at home and so what food they would need. "Maybe it is this single life, that one is much more out and about and not so much at home." (Susanna). Families also reported issues with unpredictability, albeit for different reasons, and not having regular food habits: "with my husband eating dinner is very different, he is eating nothing or eating a lot" (Ida). His quite unpredictable eating habits therefore made shopping planning very difficult for her, even when she thought she had planned she still ended up throwing out food because of this.

4.1.2. Shopping Routines. People's shopping routines, especially in relation to how often they shopped, often depended on factors other than just personal preference or social circumstance. For example, space for storing food at home was a factor, as illustrated by Ida: "our fridge here is very small and therefore we need to go shopping quite often." On the other hand, the more space people had for storing the harder it was for them to be able to see quickly all that was in the cupboard or fridge to make a plan.

Another factor strongly implicated in people's shopping routines was the very functional matter of geographical access. For Sandra, and many of our participants who lived in the city, access was easy: "luckily there are many food retailers around the corner" (Sandra). However, for the participants living in rural areas or a small village, this was not the case. They often reported having to go by car for grocery shopping.

Related to geographical access was the means of transportation that people used. The frequency and size of shopping trips depended on whether they went by car, bike, public transport, or by foot. This in turn highly depended on whether they lived in the city or in rural areas. In the countryside, every participant had a car and most of the participants used the car for grocery shopping. Only one out of nine of our households in the city had a car, and all of them went grocery shopping by foot or bike. Frank, located

in the city and a frequent shopper, discussed the importance of "heaviness" and "size" of products relative to the type of bag he had with him and what items he could fit into it. Similarly Ida, located in a little village in the countryside, stated, "During the week shopping is daily or every second day. If the yogurt runs out, or we need some fruits I do grocery shopping that fits well into a bag and which I can carry comfortably." For these smaller more frequent shopping trips lists were considered to be less important.

4.1.3. Buying. With or without planning, many participants mentioned buying more than they intended or really needed when they were shopping. A frequent example was imagining they would (or wanting to) cook healthy meals and buying foods for this, but then not having any time or energy to actually cook. Wilma described it this way: "It happens frequently with vegetables, for example, broccoli, because we [Wilma and her husband] don't shop in any coordinated way. And you can feel like you want to cook something healthy and should buy vegetables at the food retailer—well, and then you buy and never cook them." This is a typical example of the intention-behavior gap mentioned previously.

Another common example was around "economy of scale", namely that big quantities were less expensive than small ones, but this often resulted in buying too much and then it being thrown away. "Well if I can have a big package for a little more money, why should I buy the smaller one? But in the end, if I throw away the rest of it, it doesn't add up, so this [buying big packages] *is nonsense then*" (Susanna).

Overbuying was also caused by a lack of planning and not knowing what goods were already at home, as reported by Ida: "I buy something that was already in the fridge and I was thinking is not there."

Overbuying can also happen inadvertently as discussed previously, in the case of unpredictability of presence at home due to spontaneous and busy lifestyles or in Ida's case when she thought she had planned meals and bought accordingly but then found food didn't get used because of her husband's unpredictable eating habits. There were also occasions of special or "out of the routine" purchases that could result in waste. For example, Yvonne reported "when [my eldest daughter] comes for a visit I always buy this kind of cheese she likes so much." If not eaten by the daughter though, it would then be thrown out.

Overbuying can also happen as a consequence of lack of action, as in William's case. He had a box of vegetables delivered to his home every week but always ended up throwing away one particular vegetable he didn't like. He knew he should have changed the order or cancelled, but avoided it because the interface of the online shopping homepage he used was very complicated.

4.2. Managing Food at Home

The management of food once brought into the home entailed another set of routine practices around storing, cooking, processing, etc.

4.2.1. Storing. Most food brought into the home was not consumed immediately but was instead stored for later use. The routine practices of people around storage, tied up with the space available to them, had significant influence on the durability and freshness of food and ultimately on food waste. Participants revealed very different ways of storing certain foods, depending on their living situations. It was obvious that those participants who had more space were also using it to store more food. For example, Jasmin lived in a big house with a big garden, and also a cellar. She produced jars of jam out of harvested fruits in the summer and stored them in her cellar to eat in winter.

Many participants also had "systems" of having special places for particular types of foods. For example, many used particular shelves in the fridge for particular items

Fig. 3.   Susanna's glass jars as a strategy for more visibility and appreciation of food (left). Stephen discussed how to process the old apple because he does not want to throw it away (right).

such as vegetables, dairy products, and meat. Participants in shared households had particular shelves in the fridge that were theirs to use. Fruits were often kept in a bowl on a table outside of the fridge, and foodstuff with a longer durability such as cereals or cans were grouped together and kept on shelves or in drawers.

Some participants also had particular strategies for both making it easier to see what they had and to manage their storage "aesthetics". These were particularly important for being able to gain a quick overview of the cupboards, e.g., when planning lists and to keep track of what food is in the house. "There is a ritual that [...] I free them [the cereals] from their packaging and put them into big glass jars. It also looks more fancy that way. [...] I do that deliberately to have a better overview of what I have" (Susanna) (see Figure 3, left).

4.2.2. Cooking/Using. Cooking practices varied greatly between participants and, as it happened, between the UK and Austria (with only three households from the UK this is obviously not culturally representative, rather just a note of difference as we found it). For Michael, cooking was carried out to live rather than to enjoy: "to me you eat to live." Rose and Maria reported at the entrance interview that they cooked everyday with fresh food but seemed to have a great change in lifestyle during the FridgeCam study period and were heating up frozen and tinned food for cooking. Victor, coming from a Greek tradition of cooking with fresh food, tried to recreate certain dishes such as salads and grilled chicken that reflected his family traditions. Families had differently varied cooking practices, again having to deal with cooking for multiple people in the family who often had different routines and preferences. For example, Wilma and Noah's children ate at school so they tended to have simple evening meals during the week and only cooked "properly" at the weekend when they had more time. Jasmin often cooked for five people even though she lived alone because she cooked for her daughter's family.

4.2.3. Processing Available Food. Many participants engaged in very proactive strategies to use the food they had with the aim of wasting less. Several participants described how they would first look in the fridge to see what was available and then decide what to cook and eat. In this regard, Yvonne talked about the differences between her life being employed and being retired, and between having children living in the house or not: "In the past it often happened that I bought something where I thought I am going to cook something with that and then I didn't do it. Now this doesn't happen any more, because now I have a look [into the fridge] and say to myself: "This is here and I should process it." And then it is cooked."

They had different strategies to first judge if food was still edible or to be wasted. Many relied on use-by dates of products, though for vegetables and fruits the feel and

smell was more the decisive factor. Food was then considered to be edible in certain ways and processing available foods was particularly important for vegetables and fruits that spoiled very easily. One strategy, discussed by Stephen, was to find alternative ways to cook or eat such food. "I'm thinking about it [the old apple] more or less a week already, that I have to eat it. I reckon that it [the apple] tastes not bad; I'm eating an apple like that still. I probably wouldn't bite off a piece and eat it but I'd cut it and eat it in a muesli or so, you can perfectly eat that" (see Figure 3, right). Maria also talked about adding "mouldy" fruits to her porridge.

The Internet was also a source of inspiration for people trying to use up food and eight participants mentioned looking up recipes on the Internet once in a while. They often described having food in the fridge that they didn't know what to cook with and putting these as search terms to look for recipe ideas.

Another frequently cited strategy to prevent food waste was to buy food with greater durability, for example, zucchini was a vegetable perceived to last longer than others. Another strategy was to process food to extend its use. During the home tour at Jasmin's house, for example, she showed her glass jars filled with jam made from fresh berries she had picked. Processing the berries into jam was a positive strategy to increase the durability of the berries and thus allowing for them to be eaten in winter.

Making choices about using available food also required energy and effort which for some was very difficult, especially as many had very busy lifestyles: "There is a very tight time frame where I am actually very exhausted coming from work and wanting some rest and then I have to serve food to everybody [my family] and this I find exhausting" (Ida). For William being busy was also a factor and he described how food spoiled more often in certain weeks when he was particularly busy or out a lot.

There is also the matter of simply forgetting, often also associated with being too busy. Susanna, for example, talked about her intention not to throw away food. "What I am really annoyed about is, because I think it is a pity, that I really throw away a lot of food—because I totally forget about it." Although Susanna is aware of these practices she feels she has no time or energy to do anything about her food waste.

4.3. Gardening

An interesting point of contrast among our participants was the different experiences of those who were able to grow some of their own food in some way. Hence, shops were not the only source of food for some of our participants. Brunner et al. [2007] highlight the relation between growing up with one's own production or home gardening and a tendency towards sustainable food practices. We observed similar patterns with those participants who produced their own food, for example, in the garden of a family house (see Figure 4, left), in pots on a balcony or window sill (see Figure 4, right) of an apartment or on a farm. The important factors related to gardening and food seem to be: instantaneous availability and freshness, trust and valuing the food source as being connected to gardening and experiencing the planting, growing, harvesting or foraging for food in the wild.

In regard to instant availability and freshness, Jasmin pointed out that the main benefit of having fruits and vegetables readily available in her own garden was that "I can harvest it when I want to" when it is needed and without a long transportation chain. The benefit of instant availability was also connected to freshness, as participants found that the fruits and vegetables not harvested remained fresh for some time in the garden. An added benefit was a decreased demand for storage space. Freshness was an important dimension in talking about gardening and also collecting fruits or mushrooms in the wild, as some participants also did.

In addition to freshness as a significant benefit, Wilma pointed out that self-grown foods tasted much better than products from the food retailer. Wilma's husband, Noah,

Fig. 4. Wilma's fresh and readily available vegetables for the summer (left), William's herbs in pots sitting at the window sill of his apartment (right).

agreed: "The other day you made some cauliflower [harvested from the garden] which was just amazing, I've never eaten cauliflower like that before, it was simply so tasty."

For participants, growing their own food was not only a matter of freshness and instant availability, but also of trust. Self-grown foods provided complete transparency in their origin and the methods and materials of production and harvesting. "I never peel my own cucumbers from the garden, but when I shop them at the food retailer I peel them, as you never know how they were treated" (Jasmin). The experience of handling food from source, through cultivation or collection, enhanced connectivity to and appreciation of where and how food is grown and sourced. Noah stated: "if one harvests on his/her own, for example, mushrooms or so, it tastes especially good somehow." Susanna adds more detail and explains, "[. . .] the own harvested vegetables are much less likely to be thrown away because you can see and feel how much work it is to grow and harvest them." This illustrates a close connection between the experience of growing and harvesting food and attributing more value to it.

Having outdoor space to grow food could also be associated with very different relationships with waste. Anna, for example, was an organic farmer for whom regionality and sustainability were important. For her, food waste was not a problem as food "waste" was simply recycled naturally and she fed leftovers and peelings to her chicken, cows, and pigs. Two other participants with a garden also had compost heaps where they transformed nonedible fruits and vegetables into compost that they would then use to fertilize the vegetable garden bed. Hence negative connotations associated with "waste" are not so much a function of not being eaten, but of what happens to it after not being eaten.

5. FINDINGS FROM FRIDGECAM INTERVENTION

As previously described in the methods section, we also asked five of the participant households if they would allow us to install a technology probe, FridgeCam, in their homes for one month (see Table I). The purpose of the FridgeCam was to further stimulate reflections around food and waste as well as open up discussions more generally about a possible role for technology.

We present briefly a view of how the FridgeCam images were used and then in more depth how it, and in particular the time-lapse video (see Figure 2) was used as a reflective intervention.

5.1. Description of FridgeCam Probe

Each FridgeCam installation had its own Web page showing the latest 15 images. Participants were able to see only the household's own FridgeCam Web page and
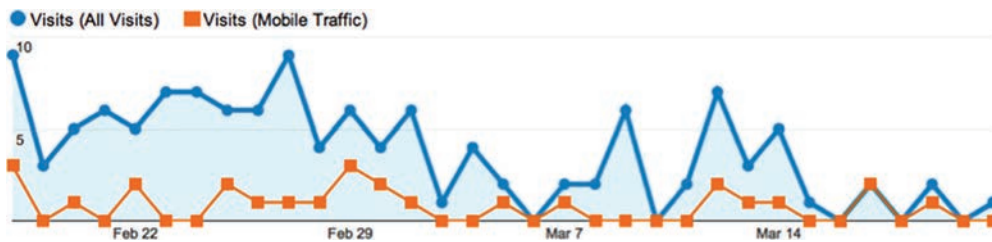
Fig. 5. Access to all FridgeCam Web sites over the course of the study. Blue (dark grey) dots represent all visits, while orange (light grey) quads show visits from mobile devices.

not others. During the recruitment phase, participants expressed that the fridge was a personal space and one that they were not readily willing to share with others. Over the four-week period, there were 123 visits to the five Web pages, with 26 of these coming from mobile devices. There were 32 unique visitors to the pages, including visitors from outside the study (e.g., seven visits from Victor's parents in Greece). While visits occurred across the four weeks of the study, there was some decline in the third week and final days of the study (see Figure 5). The average visit to the site lasted 2 min 43 sec from all visitors, with visits from mobile devices lasting on average 3 min 19 sec.

Although each FridgeCam's Web site received visits throughout the study, the reasons for these visits were not always as expected. We had anticipated that people would access the sites using mobile devices "on-the-go", for example, as a support when they were shopping to remind them of what they had already. However, this was not the case as only 26 of 123 visits were mobile. Instead participants mainly accessed the sites from non-mobile devices and reported a number of reasons to visit the site, including: to ensure it was still working; to demonstrate the novelty of the system to others; and as a memory aid and information source in advance of going shopping. Next we explore participants' reflections on their use of the FridgeCam system and the everyday food practices they elucidate.

5.2. FridgeCam Stories

The most frequent users of FridgeCam were Susanna, Philip, and Frank (both the Austrian households). In total they made 56 visits (14 from a mobile device), which lasted on average 4:19 minutes, and regularly used FridgeCam to support shopping activities. All the participants expressed an interest in keeping the FridgeCam system beyond the period of the study.

5.2.1. Susanna—Pragmatic Use. Susanna found the FridgeCam particularly useful for managing the balance between wanting to cook and eat fresh vegetarian food but not being at home often due to her busy working and social life. FridgeCam enabled her to do shopping planning just as she needed it: "So I often look [at the Web site] from my PC, for example, when I am heading off from work and think: 'Do I have enough to eat at home? Do I have to stop at the supermarket?' And then I can have a short look into my fridge." Susanna also accessed the site from her mobile while at the shop. She valued FridgeCam's support to only buy what she needed without having to think too far in advance, as she thinks it is a "*pity*" to throw food away.

5.2.2. Philip and Frank—from Quantities to Visual Images. Philip and Frank both worked in a technical domain and shared a flat together. They tried to coordinate their shopping activities by calling each other or chatting via instant messaging. They consumed large quantities of milk, though the precise volume changed from day to day. Frank did not use the FridgeCam Web site because he wasn't interested. Philip was the active user

Fig. 6.   Philip uses a FridgeCam preview at the starting window of his Internet browser (left). A FridgeCam image from Maria's and Rose's fridge they thought to be very empty (right).

in the household and placed a preview of the Web site on the starting window of his browser (see Figure 6, left) so that it was always "at hand". Similar to Susanna, he reported using the Web site to assess what he had to buy (for example, how much milk) at or near the time when he was going to the shop. He accessed the site from different contexts, for example, from his desk at work and also from his smart phone when traveling by underground train. Using FridgeCam changed his perception of the fridge itself and he now thinks of his fridge as the FridgeCam version of it: "Traditionally I thought about my fridge in terms of quantities like how much milk we have left, but not only that this picture wouldn't have come to my mind previously, when I visualize our fridge now, I can really see the FridgeCam picture in my mind."

The usage patterns for Michael, Victor, and Rose and Maria (all three households in the UK) were quite different from Susanna and Frank's usage. In total they accessed the site 50 times (12 from a mobile device) but in contrast to the Austrian households, their visits only lasted on average 47 seconds. They were all apologetic that they hadn't engaged with the FridgeCam more and in fact said they frequently forgot that the Fridge-Cam was in their fridge or that the images were available to them on the Internet.

5.2.3. Michael—Organization and Discipline. Michael lived very healthily, though he had to count costs as he was a "poor student," and he would also calculate his minimum nutritional requirements to support his exercising. As such he really needed to be efficient and organized, both with his time and costs, often trading-off taste or enjoyment of food and shopping for the same things every week. Being so organized and disciplined, it was understandable then that he didn't use the FridgeCam to support shopping. Michael found, however, that the time-lapse video of the fridge was useful for capturing people's stories. Watching the video of his own shelf in the fridge, he commented that: "it tells … that my habits are incredibly consistent." As the fridge was also shared with his housemates, the time-lapse video also showed the shelves and activities of his housemates. Here he reflects: "*when you get it* [the Fridgecam images] *in series it actually tells the story, the problem is trying to understand what the story is.*" While he could understand his own practice, the changing food on his flatmates' shelves described a different set of practices. This is "*quite subtle. It is not like quite, you know, dramatic in any way, but there is a story about something, I suppose food storage. The food storage story.*"

5.2.4. Rose and Maria—Reflecting on Past Food Practices. In Rose and Maria's house, it was Maria who took on the responsibility for the food. She reported that she was very conscious of what food they ate and was the one who wrote the shopping lists and was also very careful about costs and not to shop too much. They also reported cooking every day with fresh food at the entrance interview. After the study period though, their reports and the FridgeCam video painted a very different picture to how they previously reported that they managed their food. They were surprised to see how little food was actually in the fridge over the course of the month (see Figure 6, right), leading Rose to wonder, "How do we live?" The FridgeCam showed them that the reality of their everyday practices did not reflect their aspirations about appropriate food practice or their perceptions of their own practices. Just as Michael had wondered what the "food storage story" was for his flatmates, so too did Rose and Maria, this time pondering what their own "story" meant. Here they could reconstruct cooking particular meals, but did not recognize the overall pattern. On reflection they discussed that they had eaten out a lot as they went out a lot and when they did eat at home they ate mostly frozen or tinned food as they were also on a tight budget "food from the cupboard" as they called it: "It is cheaper to buy frozen food, frozen vegetables" (Maria); "tinned things . . . it doesn't go off" (Rose).

5.2.5. Victor—a Fridge to Communicate Presence. Victor also did not use the FridgeCam Web site frequently. When asked if he saw any changes in his food practices during the deployment he commented: "I don't see any big changes, I guess my fridge is the same all the time. So that proves what I am thinking about how I am using the fridge. So I am using the fridge just for buying things, just the things for the day. So I guess the [time-lapse] video proves the, this thing that I don't buy many things sometimes. And some other day the fridge is empty."

Victor's only food waste, based on self-report, was caused by the supermarket not selling smaller packets of food. He could only cook and consume a certain amount of, for instance, chicken, and anything that was packed in quantities beyond that was wasted. The only exceptions to this were special food items, such as olives, that he brought from Greece. These became the focus of a discussion with his parents after he showed them the FridgeCam Web site. When asked about accessing the site, he joked that his parents probably used it more than he did (there were seven Web site visits from Greece). Worried about what he was eating, his parents checked the Web site and quizzed him on what he had in the fridge: "Probably because when they couldn't find me on the phone they asked me, they normally ask me things like what do you have for lunch? Or what did you have for dinner today? And things like that. [. . .] So probably when they don't find me in Skype they were just checking my fridge to see if I'm alright and if I ate something" (Victor).

Thus for Victor FridgeCam was less about how he monitored his own food and more about how it fitted into his relationship with his parents. Their practices of communicating with him, worrying about whether he was eating well, and keeping up to date with his life were augmented by the view provided by FridgeCam.

The stories from Susanna, Philip, Frank, Michael, Rose, Maria, and Victor reflect the complexities in people's lives and how differently every participant used or did not use FridgeCam in line with their needs. The time-lapse videos allowed them to reflect on what had happened during the last month and discover the "stories" (Victor) behind their fridges and associated practices.

6. NEGOTIATING PRACTICES TO INFORM DESIGN

In the studies presented here we have been particularly concerned to gain a broad understanding of the everyday routines and practices around food and related food

waste. From the interview and home tour data of 17 participants in 14 households, we identified rich and varied practices around shopping, storing, cooking, and processing.

Across all of our households, we saw a similar overarching pattern where none of our participants liked to throw food away and they all reported having certain "good" intentions, some motivated by sustainability others by budget or ethical concerns. But these values or intentions did not always translate into action. While none of our participants wanted to waste food, all had occasions of food waste in some form or other.

What was also clear was that food waste accrued through practices happening at points of time often long before disposing the food and resulted from factors like: buying too much to save money through large packs; not planning, forgetting what was at home or not coordinating with a partner and so doubling up on buying; having good intentions to use food bought but going out instead and having busy and unpredictable lives, and so on. We also saw people engaging in positive strategies to try to avoid waste such as: planning before shopping, storing in ways that make it easy to see what is needed, being creative and frugal in using available food, processing food to extend its durability, buying less or the right amounts, growing their own foods, and so on.

We saw how the practice of gardening created very different relationships to food and waste. When participants grew and sourced their own food, they placed greater value on the food and from more practical concerns also wasted this food less, for example, since it could be picked fresh. It also changed their relationship to waste; for Anna, waste became food again down a food chain via either composting for fertilizer or being fed to animals on her farm. This heightened an awareness of, and deep engagement with, the full pathway of food from production to either consumption through eating or consumption through recycling. This is in contrast to other contexts where the physical engagement with food for the participants was from the supermarket shelf where it "just is", to either being consumed as food or not consumed and put into the bin. What happens either side of the shelf and the bin remained largely invisible and certainly not engaged with. This is similar to what Strengers [2011] reports in relation to energy and water in the home, where water is carried invisibly into the home with a "crucial material and perceptual disconnection between domestic water use and its ecological consequences" [ibid, page 197].

That food is wasted (or not), and that there can be an intention-behavior gap, in themselves are not new findings, of course [Vermeir and Verbeke 2006]. What is more interesting is how these gaps play out in practice. The findings from this study point to some of the everyday inter-related factors contributing to this gap, some of which were also noted by Evans [2012]. There is no simple path leading up to the act of throwing away food nor is it something taken lightly or planned for by the participants. Rather food waste is an often unintended and unwanted outcome of the negotiations between practices that are deeply embedded in everyday social, spatial, cultural, and practical contexts [Blake 1999] that create competing concerns.

Broader contextual factors influenced and shaped practices and routines in interesting ways. The social context mattered and practices around planning, shopping, cooking, and eating were highly influenced by who else was in the home, such as partners, family members, or roommates. This could be in terms of changing or competing preferences influencing what was cooked, or in terms of communication and coordination around what was bought or not, or in terms of social lives and prioritizing opportunities to get together with friends over staying home and cooking available food. Even when significant or close others were no longer in the home they still had an influence, such as Susanna reporting to still cook vegetarian because her ex-boyfriend was vegetarian. Geographical and physical context also shaped and constrained practices, such as participants in the countryside having access to a garden being more

likely engaged in gardening activities than participants living in an apartment in a big dense city with apartment buildings such as Vienna.

The same geographical and physical context played out regarding transportation in the countryside, where we could observe people going shopping by car more often. So it mattered what means of transport they had available (Ida: "during the week I do shopping that fits into a bag"), what supermarkets were accessible, how much storage space they had, how their working hours, coincided with shop opening hours, and so on. One interesting difference between the UK and Austria in regard to accessibility was that supermarkets stayed open much longer in the UK and so simply created different opportunities for people to shop. These contextual factors, many of which participants had little control over, all impacted on where, when, how, and how often people could go shopping or engage in producing their own food.

6.1. A Set of Considerations for Food Waste

It is possible to frame the negotiations in everyday practices around food and waste as, in Schatzki's reference to Oakeshott, the "set of considerations that governs how people act" [1996, page 96]. That is, for many of the participants in our study considerations had to be made across a number of concerns, for example, for the available time to shop or cook, the number of people who would eat the meal, or the storage space available to store ingredients. However, it is clear, as Schatzki [ibid] points out, that these "considerations" do not exist outside of the practices in which they are concerned. Instead, these considerations take on their meaning as embodied and enacted in the everyday practices of food management. Moreover, we note from our data that these considerations are most evident in the moments of discretionary consumption that are produced as dispersed practices and are transformed in the enactment of integrated practices.

Shopping, as an integrated practice, for example, was conducted by some participants in the context of another dispersed practice such as "living on a tight budget" (i.e., dispersed across any practices that entail spending money), leading people to choose larger packages that were perceived as less expensive but also increased the likelihood that they would later throw away the unused extra, as noted by Susanna. The dispersed practice of "having a social life" often took higher priority than staying at home to cook food that had been bought, with all good intention to use it, but the discretionary choice to go out instead of cooking again increased the likelihood of the food not being used, as with William. And the dispersed practice of "caring for the family" often resulted in taking more concern for the unpredictable eating preferences for the day than strictly using what was bought for cooking, as with Ida and her husband.

Busy lives and working practices were also entailed in moments of consumption in numerous ways: Wilma and Noah, who were very busy and for whom shopping became an incidental activity on the way home from work, often shopped without much forethought or without communication or coordination with each other, and William's busy weeks coincided with him throwing out more food. The efficiency of shopping, as managed by creating lists beforehand, was a trade-off between having the time to create the list, being organized enough to do so, and being able to easily see what was needed. While, for instance, shopping might be supported as an isolated, integrated practice, it is important to recognize that integrated practices also serve as a nexus for diverse dispersed practices. For our participants dispersed practices, such as "living on a tight budget", "managing time", etc., are intertwined with integrated practices such as shopping. These integrative practices entail complex inter-relationships and negotiations around competing values and circumstances.

The moments of discretionary consumption were often framed then by both the everyday practices and routines of life and these broader contextual factors. Further, some of the practices were perceived as the non-negotiable [Strengers 2011; Pierce

et al. 2010] and mundane parts of managing everyday life, such as balancing tight budgets and needing to eat. Thus, any "designerly" aims to support a reduction in food waste must respect the values and perceptions of the individual as he/she negotiates, these different relative priorities in situated moments of practice. This is particularly so given that participants are already aware of intention-behavior gaps in their food practices, and experience these negatively.

Food waste, then, is a complex issue when it comes to design. There are opportunities for interactive technologies to support and bridge spatial, social, or temporal constraints. Other issues, such as busyness and lack of energy that people experience in their daily lives that become implicated in food waste, are harder to tackle. These interrelationships among everyday practices, contexts, and values and the dispersal of moments of consumption across time and space (that can eventually lead to the final act of throwing out food) suggest that there is no simple or single design implication to draw out. This is also reflected in the varied responses of our participants to FridgeCam, where some participants found it useful and others did not engage with it at all. It also seems clear that focusing design interventions specifically on reducing food waste is missing the point that participants were already very aware that their intentions not to waste food did not always translate into practice and were not comfortable about that.

6.2. Learning from FridgeCam

The deployment of FridgeCam as a one-month technology probe allowed us to explore food practices in a different way as well as to try out a technology intervention in five of the 14 households. The FridgeCam study elucidated the interstices of everyday integrated practices (cooking, shopping, exercizing, socializing) where the values within which food management, consumption, and disposal were performed were called upon. Examples of these values for the FridgeCam participants were living healthily (Michael) or wanting to cook fresh food (Susanna). It is evident that, in reflecting on their food practices, FridgeCam users drew on "ways of doing" foods, rather than their food values, which fall out of and fill the gaps between their everyday practices. FridgeCam as a probe intervention served as a useful point of reflection for some participants through the time-lapse videos to see how their intended lifestyle of cooking and healthy eating did not translate into practice (Maria and Rose).

FridgeCam also provided a very practical opportunity to show that technology could support values around careful food shopping. Having access to the pictures enabled some of the participants to renegotiate their engagement between different practices, for example, around planning and shopping, where Susanna and Philip used FridgeCam as a support for shopping planning, remembering, and checking their foods. However, this was clearly not the case for everyone. The other participants just didn't need such an intervention to support everyday practices, as in the case for Victor who shopped every day for fresh food anyway and Michael who had rigid weekly patterns of how he shopped, cooked, and ate.

We go on here to identify a range of possible design strategies beyond FridgeCam and suggest that participants might choose some ensemble of these as they self-identify where and how support might be useful in the context of their own everyday lives, contexts, and values. We consider design strategies as both support for dispersed practices (Section 6.3) that occur across many sites of food production, purchasing, consumption, and waste, and support for the integrated practices (Section 6.4) that are shaped from these dispersed practices and their own rules and goals.

6.3. Support for Dispersed Practices

Through a practice lens then, the final action of throwing food away is not itself an integrated practice but a final act in a dispersed practice of consumption or, to be more

precise here in relation to food waste, of discretionary nonconsumption. Warde [2005] argues that "all integrative practices require and entail consumption" in some way. He defines consumption as "a process whereby agents engage in appropriation and appreciation [...] of goods, services, performances, information or ambience, whether purchased or not, over which the agent has some discretion" [ibid, page 137] and suggests that "consumption could be considered a dispersed practice." Wasting food then is a moment interwoven into other practices and itself arises from multiple other moments of consumption across multiple other practices, for example, shopping, storing, cooking, processing, etc., that take place both inside and outside the home. The potential consequences of these other moments of consumption for creating food waste are, like consumption itself, almost "inescapable, momentary and occurs often without mind" [Warde 2005, page 150].

In our data, there were the obvious moments of discretionary consumption and, by extension for waste, of nonconsumption. These happened when people were at the shops buying food, or in the kitchen deciding what foods to eat, that is, as part of integrative practices of shopping and cooking. But what happened in that moment of discretionary choice was often in a chain of choices and the final outcome of complex negotiations and trade-offs between other concurrent practices and as well practical constraints and values.

Those moments of discretionary consumption as dispersed practices are often unseen in the more complex integrated practices of cooking, shopping, and so on. If food is wasted as a by-product, then it may be reasonable to assume that food waste can be avoided similarly through further or alternative transformation of these practices, such as Susanna and Philip using FridgeCam as a support for the integrated practice of shopping. Designing interventions requires a consideration of the complex nexus of interconnected practices (dispersed and integrated) that define food practices. The visibility of the connections (and disconnects) between these practices provides a means to design for the reduction of food waste. The relationships between, for instance, purchasing and waste, or gardening and consumption, provide a means to add to the value of food. Some strategies to support dispersed practices might include the following.

—Make the connections between moments of consumption and their possible implications for later food waste more visible, for example, connecting shopping with histories of food waste taking a personal informatics approach.
—Make the full pathways of food more visible, for example, the work on source of food [Bonanni et al. 2010] or food miles [Kalnikaite et al. 2011].
—Make the costs, sustainable, ethical, and health impacts more visible, for example, through a food calculator showing energy consumption of food production (similarities to activist awareness campaigns).
—Create mediated opportunities to engage with food sourcing and connect with food values where actual opportunities are not available, for example, an online map where food can be sourced in the wild[5] or a virtual garden.
—Support reflection on where and how the intention-behavior gap plays out, for example, as the FridgeCam video did for some participants.

6.4. Support for Integrated Practices

As evidenced in our data, it is also possible to provide practical supports for the integrated practices from which food waste occurs. The strategies individuals already employ in the doing (and saying) of integrated practices, in the embodied enacting of

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[5]http://www.mundraub.org/.

these practices, provide some examples. While it may not be necessary in these cases to explicitly aim to reduce food waste (e.g., it may simply be more aesthetically pleasing to store foods in glass jars), reducing food waste can be a likely secondary benefit. Thus while the intention-behavior gap remains a significant difficulty for individuals, the reframing of relevant actions (such as discarding food due to overbuying) within the integrated practices, for example, of storing, gives these intentions (as might be formed in dispersed practices) the particularity of an embodied enactment which the individual can perform. Thus in the integrated practices we might clearly identify within the food domain (such as shopping, storing, cooking, etc.) we can design for technological support for embodied actions by, for example, offering a disembodied view inside the fridge or extending the communication of and around food practices in the home, neighborhood, and wider society. Strategies for supporting moments of action within integrated practices can include the following.

—Support planning and shopping by making information accessible and visible at the moment of consumption/buying, for example, as with FridgeCam Web site images to see what is in the fridge and smart fridges making it easier to see what is at home.
—Support storing and managing inventory by making it easier to see what is available and what foods have to be used, for example, barcode readers for an intelligent fridge or reinterpreting Gaver et al.'s history tablecloth [2006] for a cupboard.
—Promote specific practices in which "food is done" to promote more sustainable in-the-moment choices, for example, as looking up recipes for available ingredients does when part of cooking practice.
—Coordinate the organization of food consumption within and between households, for example, to share or trade superfluous food between households, thus extending the social unit involved in food.
—Promote actual gardening by creating connections between people to share gardens, for example, connecting the older person who can no longer manage a garden and a younger person who can't afford a garden of his/her own but wants to grow his/her own food.
—Connect together people who can share strategies, stories, food, resources, and values, for example, by leveraging social networking tools, and/or sharing FridgeCams, BinCams, etc.

The aforementioned statements, in this and the previous section, can be taken as starting points, meant to provide first orientations to inform design. Our material points to the discrepancies and negotiations between the intentions held by individuals and their integrated and dispersed practices. We need to respect the discretionary choices of participants as free "agents" [Warde 2005], and the fine negotiations that only they are able to make at the moment of action, and not impose some decontextualized normative judgement or positivist behavior-change agenda around waste. As noted by Sellen et al. [2009] it is about considering the human aspects of daily lives and that we function and act within an environment with given structural conditions.

7. CONCLUSIONS

Sustainability is a critical societal issue but food waste is an area in designing technologies for sustainability that has yet to receive much attention from the HCI community. Our findings suggest that choices about food and waste are often determined by or embedded in the environment rather than the attitude or motivation of our participants and in diverse integrated practices of shopping, storing, cooking, gardening, etc. Occasions for waste emerge as a later consequence from multiple other moments of consumption within practices. Consumption or nonconsumption of food is embodied and enacted within the conditions of the moment, and is the outcome of multiple negotiated

concerns. While none of our participants wanted to waste food, waste was still an almost invisible and unconscious result of previous discretionary decisions, bound within practices.

Based on our findings we have highlighted a number of design opportunities to support the complex daily practices (both integrated and dispersed) that people have to negotiate and through which food waste can arise. The strategies that we propose are aimed at supporting the everyday practices of individuals regardless of their outcomes. We aim to support those intentions that the individuals clearly profess, but often cannot enact, by enabling the connections between dispersed practices to be seen and providing support for the embodied actions of integrated practices as individuals engage with food.

In ongoing work, we are exploring specific instantiations of some of our design strategies. Specifically, ongoing use of FridgeCam is already continuing as the two Austrian households asked to keep the system for a longer period of time to see if they continue using it when the novelty effect disappears. This will enable us to explore if and how FridgeCam becomes domesticated into shopping and other practices. We also plan to explore one of the proposed strategies for integrated practices, for example, support to share superfluous food between households. Ultimately, we hope this contribution inspires future research into how and which technologies can intervene to support sustainable food practices and avoid food waste.

ELECTRONIC APPENDIX

The electronic appendix for this article, a time-lapse video of one of the participant's fridges, can be accessed in the ACM Digital Library.

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REFERENCES

AMBLER-EDWARDS, S., BAILEY, K., KIFF, A., LANG, T., LEE, R., MARSDEN, T., SIMONS, D., AND TIBBS, H. 2009. Food futures: Rethinking uk strategy. Tech. rep., Chatham House.

ARNOLD, M. 2004. The connected home: Probing the effects and affects of domesticated icts. In *Proceedings of the 8th Biennial Participatory Design Conference*. 183–186.

BELTON, P. AND BELTON, T. 2002. *Food, Science and Society: Exploring the Gap Between Expert Advice and Individual Behaviour*. Springer.

BLAKE, J. 1999. Overcoming the 'value-action gap' in environmental policy: Tensions between national policy and local experience. *Local Environ: Int. J. Justice Sustain. 4*, 3, 257–278.

BRAUN, V. AND CLARKE, V., 2006. Using thematic analysis in psychology. *Qualitative Res. Psychol. 3*, 2, 77–101.

BLEVIS, E. AND MORSE, S. C. 2009. Sustainably ours: Food, dude. *Interact. 16*, 2, 58–62.

BONANNI, L., HOCKENBERRY, M., ZWARG, D., CSIKSZENTMIHALYI, C., AND ISHII, H. 2010. Small business applications of sourcemap: A web tool for sustainable design and supply chain transparency. In *Proceedings of the 28th International Conference on Human Factors in Computing Systems (CHI'10)*. ACM Press, New York, 937–946.

BRUNNER, K.-M., GEYER, S., JELENKO, M., WEISS, W., AND ASTLEITHNER, F. 2007. *Ernährungsalltag im Wandel: Chancen für Nachhaltigkeit*. Springer.

BUCCI, M., CALEFATO, C., COLOMBETTI, S., MILANI, M., AND MONTANARI, R. 2010. Fridge fridge on the wall: What can I cook for us all?: An hmi study for an intelligent fridge. In *Proceedings of the International Conference on Advanced Visual Interfaces (AVI'10)*. G. Santucci, Ed., ACM Press, New York, 415–415.

CHI, P., CHEN, J., CHU, H., AND CHEN, B. Y. 2007. Enabling nutrition-aware cooking in a smart kitchen. In Proceedings of the *Extended Abstracts on Human Factors in Computing Systems (CHI EA'07)*. ACM Press, New York, 2333–2338.

CHOI, J. H. AND BLEVIS, E. 2010. HCI and sustainable food culture: A design framework for engagement. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries (NordiCHI'10)*. ACM Press, New York, 112–117.

CONNER, M. AND ARMITAGE, C. J. 2002. *The Social Psychology of Food*. Open University Press, Philadelphia, PA.

CONSOLVO, S., MCDONALD, D. W., AND LANDAY, J. A. 2009. Theory-driven design strategies for technologies that support behavior change in everyday life. In *Proceedings of the 27th International Conference on Human Factors in Computing Systems (CHI'09)*. ACM Press, New York, 405–414.

CUELLAR, A. D. AND WEBBER, M. E. 2010. Wasted food, wasted energy: The embedded energy in food waste in the united states. *Environ. Sci. Technol. 44*, 16, 6464–6469.

DISALVO, C. SENGERS, P., AND BRYNJARSDÓTTIR, H. 2010. Mapping the landscape of sustainable hci. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'10)*. ACM Press, New York, 1975–1984.

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 (DIS'10)*. ACM Press, New York, 1–10.

ESHEL, G. AND MARTIN, P. A. 2006. Diet, energy, and global warming. *Earth Interact. 10*, 9, 1–17.

EVANS, D. 2012. Beyond the throwaway society: Ordinary domestic practice and a sociological approach to household food. *J. Sociol. 46*, 1, 41–56.

FITZPATRICK, G. AND SMITH, G. 2009. Technology-enabled feedback on domestic energy consumption: Articulating a set of design concerns. *IEEE Pervas. Comput. 8*, 1, 37–44.

FROEHLICH, J., FINDLATER, L., AND LANDAY, J. 2010. The design of eco-feedback technology. In *Proceedings of the 28th International Conference on Human Factors in Computing Systems (CHI'10)*. ACM, New York, 1999–2008.

FROEHLICH, J., DILLAHUNT, T., KLASNJA, P., MANKOFF, J., CONSOLVO, S., HARRISON, B., AND LANDAY, J. A. 2009. Ubigreen: Investigating a mobile tool for tracking and supporting green transportation habits. In *Proceedings of the 27th International Conference on Human Factors in Computing Systems (CHI'09)*. ACM Press, New York, 1043–1052.

GAVER, W., BOWERS, J., BOUCHER, A., LAW, A., PENNINGTON, S., AND VILLAR, N. 2006. The history tablecloth: Illuminating domestic activity. In *Proceedings of the 6th Conference on Designing Interactive Systems (DIS'06)*. ACM Press, New York, 199–208.

GRIMES, A., BEDNAR, M., BOLTER, J. D., AND GRINTER, R. E. 2008. Eatwell: Sharing nutrition related memories in a low-income community. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW'08)*. ACM Press, New York, 87–96.

GRIMES, A. AND HARPER, R. 2008. Celebratory technology: New directions for food research in hci. In *Proceedings of the 26th Annual SIGCHI Conference on Human Factors in Computing Systems (CHI'08)*. ACM Press, New York, 467–476.

GUSTAVSSON, J., CEDERBERG, C., AND SONESSON, U. 2011. Cutting food waste to feed the world global food losses and food waste. Tech. rep., United Nations Food and Agriculture Organisation.

HALL, K. D., GUO, J., DORE, M., AND CHOW, C. C. 2009. The progressive increase of food waste in america and its environmental impact. *PLoS ONE 4*, 11, e7940.

HE, H. A., GREENBERG, S., AND HUANG, E. M. 2010. One size does not fit all: Applying the transtheoretical model to energy feedback technology design. In *Proceedings of the 28th International Conference on Human Factors in Computing Systems (CHI'10)*. ACM Press, New York, 927–936.

HUTCHINSON, H., MACKAY, W., WESTERLUND, B., BEDERSON, B. B., DRUIN, A., PLAISANT, C., BEAUDOUIN-LAFON, M., CONVERSY, S., EVANS, H., HANSEN, H., ROUSSEL, N. AND EIDERBÄCK, B. 2003. Technology probes: Inspiring design for and with families. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'03)*. ACM Press, New York, 17–24.

IPCC AR4 SYR. 2007. Fourth assessment report of the intergovernmental panel on climate change 2007: Synthesis report. Tech. rep., IPCC, Geneva.

JELSMA, J. 2006. Designing 'moralized' products: theory and practice. In *User Behavior and Technology Development: Shaping Sustainable Relations Between Consumers and Technologies*. P.-P. Verbeek and A. Slob, Eds., Springer, 221–231

KAISER, M. L. 2011. Food security: An ecological-social analysis to promote social development. *J. Community Pract. 19*, 1, 62–79.

KALNIKAITE, V., ROGERS, Y., BIRD, J., VILLAR, N., BACHOUR, K., PAYNE, S., TODD, P. M., SCHÖNING, J., KRÜGER, A., AND KREITMAYER, S. 2011. How to nudge in situ: Designing lambent devices to deliver salient information in supermarkets. In *Proceedings of the 13th International Conference on Ubiquitous Computing (UbiComp'11)*. ACM Press, New York, 11–20.

KIRMAN, B., LINEHAN, C., LAWSON, S., FOSTER, D., AND DOUGHTY, M. 2010. There's a monster in my kitchen: Using aversive feedback to motivate behaviour change. In *Proceedings of the 28th of the International Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA'10)*. ACM Press, New York, 2685–2694.

LI, L., CHEN, N., WANG, W., AND BATY, J. 2009. Localbuy: A system for serving communities with local food. In *Proceedings of the 27th International Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA'09)*. ACM Press, New York, 2823–2828.

LIGHT, A., WAKEMAN, I., ROBINSON, J., BASU, A., AND CHALMERS, D. 2010. Chutney and relish: Designing to augment the experience of shopping at a farmers' market. In *Proceedings ofthe 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction (OZCHI'10)*. ACM Press, New York, 208–215.

MAITLAND, J. AND CHALMERS, M. 2011. Designing for peer involvement in weight management. In *Proceedings of the Annual Conference on Human Factors in Computing Systems (CHI'11)*. ACM Press, New York, 315–324.

ODOM, W. 2010. "Mate, we don't need a chip to tell us the soil's dry": Opportunities for designing interactive systems to support urban food production. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS'10)*. ACM Press, New York, 232–235.

OLIVIER, P., XU, G., MONK, A., AND HOEY, J. 2009. Ambient kitchen: Designing situated services using a high fidelity prototyping environment. In *Proceedings of the 2nd International Conference on Pervasive Technologies Related to Assistive Environments (PETRA'09)*. ACM Press, New York.

PIERCE, J., FAN, C., LOMAS, D., MARCU, G., AND PAULOS, E. 2010. Some consideration on the (in) effectiveness of residential energy feedback systems. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS'10)*. ACM Press, New York, 244–247.

PIERCE, J. AND PAULOS, E. 2011. Second-hand interactions: Investigating reacquisition and dispossession practices around domestic objects. In *Proceedings of the Annual Conference on Human Factors in Computing Systems (CHI'11)*. ACM Press, New York, 2385–2394.

PIMENTEL, D., HEPPERLY, P., HANSON, J., DOUDS, D., AND SEIDEL, R. 2005. Environmental, energetic, and economic comparisons of organic and conventional farming systems. *BioSci.55*, 7, 573–582.

QUESTED, T. AND PARRY, A. 2011. New estimates for household food and drink waste in the UK. Final report. WRAP. http://www.wrap.org.uk/content/new-estimates-household-food-and-drink-wasteuk.

RECKWITZ, A. 2002. Toward a theory of social practices: A development in culturalist theorizing. *Euro. J. Social Theory 5*, 243–263.

SCHATZKI, T. R. 1996. *Social Practices: A Wittgensteinian Approach to Human Activity and the Social*. Cambridge University Press.

SCHNEIDER, F. AND LEBERSORGER, S. 2009. Untersuchung der lebensmittel im restmüll in einer oberösterreichischen region. Tech. rep., Institut für Abfallwirtschaft, BOKU, Wien.

SELLEN, A., ROGERS, Y., HARPER, R., AND RODDEN, T. 2009. Reflecting human values in the digital age. *Comm. ACM 52*, 3, 58–66.

STRENGERS, Y. A. 2011. Negotiating everyday life: The role of energy and water consumption feedback. *J. Consum. Culture 11*, 19, 319–338.

STRINGER, M., FITZPATRICK, G., AND HARRIS, E. 2006. Lessons for the future: Experiences with the installation and use of today's domestic sensors and technologies. In *Proceedings 4th International Conference on Pervasive Computing (Pervasive'06)*. Lecture Notes in Computer Science, vol. 3968, Springer, 383–399.

THIEME, A., COMBER, R., MIEBACH, J., WEEDEN, J., KRAEMER, N., LAWSON, S., AND OLIVIER, P. 2012. "We've bin watching you" – Designing for reflection and social persuasion to promote sustainable lifestyles. In *Proceedings of the 30th International Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA'12)*. ACM Press.

VERMEIR, I., AND VERBEKE, W. 2006. Sustainable food consumption: Exploring the consumer "attitude – behavioral intention" gap. *J. Agricult. Environ. Ethics 19,* 2, 169–194.

WARDE, A. 2005. Consumption and the theory of practice. *J. Consum. Culture 5*, 2, 131–154. http://joc.sagepub.com/content/5/2/131.abstract.

WEBER, C. L. AND MATTHEWS, H. S. 2008. Food-miles and the relative climate impacts of food choices in the united states. *Environ. Sci. Technol. 42,* 10, 3508–3513.

WOODRUFF, A., HASBROUCK, J., AND AUGUSTIN, S. 2008. A bright green perspective on sustainable choices. In *Proceedings of the 26th Annual SIGCHI Conference on Human Factors in Computing Systems (CHI'08)*. ACM Press, New York, 313–322.