Eco-Feedback for Non-Consumption

Abstract
Eco-feedback is a strategy to increase awareness of resource use and to encourage conservation. We applied eco-feedback on household food waste with the prospective to increase awareness and explore its impact on food related decision-making. In this paper we present a prototype of an eco-feedback system for food waste, which was deployed in a student house. In preliminary findings, participants indicated positive effects on dealing with leftovers, food preparation and reflection about food waste issues, when eco-feedback was deployed. Findings are used for the next design iteration of the concept and, for more concluding results, in a larger-scale evaluation.

Author Keywords
Eco-feedback; Food Waste; Persuasive Technology; Social Technology; Interaction Design; Human-Computer Interaction.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction
Food waste prevention is one of the key approaches to reduce environmental impacts of food related behavior. In relation to this, UNEP has set future goals to raise...
awareness on peoples food related choices and the value of food [6]. Eco-feedback is one of the strategies to increase awareness of resource use and hence encourage conservation [3]. Most related work in the recent past, however, has mainly focused on residential electricity usage, water usage, transportation, carbon tracking, the environmental impact of product purchases, recycling behavior, and paper use [3]. To our knowledge, to date, little attention has been paid on how to apply eco-feedback on reducing household food waste with the prospective to increase awareness and the impact on food related decision-making, such as less purchasing and reduced food waste.

Background
Eco-feedback is used to increase awareness by automatically sensing peoples’ activities and feeding related information back through computerized means [3]. Eco-visualizations reveal hidden environmental information and behavior patterns, and create more readily comprehensible and accessible information for a population or target group [4], with the goal of promoting sustainable behaviors or fostering positive attitudes towards sustainable practices [8]. The reasoning behind eco-feedback is also that people understand and agree to the morale behind the feedback, adopt similar mindsets, and act accordingly once they are more aware of the systematic effects of their everyday actions. Indeed, eco-feedback is based on the hypothesis that most people lack understanding and awareness about how their everyday behaviors affect the environment. A strategy commonly used in eco-feedback research is to apply social comparison as motivation for reduced consumption. Social approval, norm activation, or social comparison, are principles that humans use to influence others and seem to be successful when facilitated through technology for supporting behavior change [5]. For example, study participants were motivated to save more energy and water when they were able to compare their consumption with others [2, 7]. The cultural context also seems to be an important factor to consider: another study has shown that for collectivistic Japanese users, group comparison feedback was effective while individual comparison feedback did not produce significant effects [5]. In this paper, we present a first prototype of an eco-feedback system for food waste followed by a discussion of preliminary findings from a case study. The main contribution is on exploring the effects of social influence strategies on food related decision-making integrated in an eco-feedback system for food waste.

Design Probe
The design probe of this study is a novel augmented bin that measures food waste and give direct feedback to its users. The prototype consists of a laptop computer with custom software and a laser-cut wooden enclosure containing a USB scale, an Arduino microprocessor and additional electronics (see figure 1).

Functionalities
The bin allows for manual input from users to indicate the type of food group (grains, dairy, vegetables, fruits, and animal proteins) or whether the disposed items were leftovers from a meal. Finally, the quality of disposed food (bad, possibly bad, good) can be entered. This information is collected for quantification purposes and further analysis together with contextual information and life log/diary study. After every disposal, the date, time and grams are stored automatically in the system. Subsequently, eco-feedback (see figure 2) is provided through a display that visualizes food waste in number of meals (in this case, every 700 grams of disposed waste).
equals to one meal). A second dimension of information is provided through the color of the aggregate meals that were wasted to visualize comparison information: red indicating an higher average of daily food waste amounts in comparison to others (negative feedback) and green indicating a lower average of daily food waste amounts in comparison to others (positive feedback). Others was based on a national number of average food waste per person per day which is approx. 137 grams a day [1].

Software and Hardware Design
The laptop runs a pure-data patch which handles the collection and saving of data into a text-file, as well as the communication with the scale and Arduino. The scale is an off-the-shelf Dymo M5 USB postal scale which transmits its measurements over USB through the HID protocol via a USB connection with the laptop computer. The Arduino processor reads the buttons and controls the indication LEDs, which is controlled by the laptop through a custom protocol via a serial USB connection.

Design Rationale and Research Aims
The aim of using the eco-feedback system is to explore its effects on user interactions and decision-making processes around food of individuals as well as groups living together in a shared household.

Case study
We recruited a student house with four female students who used the system for two weeks continuously. The first week served as a baseline measurement without any interventions in terms of eco-feedback, and in the second week eco-feedback was implemented and simulated. A questionnaire study was conducted at the end of each week to explore the effects of eco-feedback (or the lack thereof). One of the authors was part of the house but pretended not to be part of the research team. Instead she presented her role as someone who just had to make sure that the bin was working and the questionnaires were filled. This ethnographic research style, allowed us to also answer specific questions through observation and informal discussions among the participants initiated by this author.

Methodology
A questionnaire study was set-up using five-point Likert scales. The questionnaire items focused on how much the bin system had an effect on personal food related behavior as well as an effect on the groups’ general food related behavior. Food behaviors were further specified in planning, purchasing, preparation, and dealing with leftovers. Other questionnaire items focused on how much the system had effects on awareness on their overall food practices, their level of motivation to change behavior, how much the system supported reflection, and finally, how they feel about the bin system. Answer options ranged from very much, somewhat, undecided, not really to not at all, with item’s score contribution from 5 to 1, respectively. The semi-structured interviews were based on the same questionnaire items, but aiming for more in-depth discussions on how the system had affected their behaviors.

Findings
The largest differences in scores were found for dealing with leftovers on an individual basis and food preparation at a group level when eco-feedback was deployed in comparison to the baseline measurement; 4 vs. 2.33 and 4.33 vs. 3, respectively (e.g. careful in the amount that is being cooked and saving leftovers for lunch). Furthermore, differences in score were also found for planning and preparation on an individual basis when eco-feedback was
deployed in comparison to the baseline measurement; 3.33 vs. 2.33. Finally, participants provided higher scores for self-reflection when eco-feedback was implemented in comparison to the baseline measurement; 5 vs 4.

**Discussion and Future Work**
Given the promising findings in the two-week study, we see a potential of providing eco-feedback of non-consumed food items on reflection and possibly behavior change. The overall eco-feedback system was perceived positively (score 4 out of 5), and the system hardware proved to be robust enough for further studies in other households and food communities. A major drawback of this first prototype, however, was that its software component needed to be restarted after once or several use cases which was slightly disturbing for users. Therefore, the system software requires improvements for further studies. Future work will include an adaptation of the system and the eco-feedback display to make it better suitable for long term studies (e.g., visualizing the number of wasted meals for at least a month). A lab study will be done to evaluate different design probes for eco-feedback (i.e., different metrics to visualize amounts and quality of wasted food). We will also replace the laptop with a raspberry pi including a Wifi module for a more compact casing and remote observation possibilities. Eventually, the system should be replicated and deployed in multiple households to acquire more extensive data over a longer time. Finally, we aim at testing eco-feedback embedded in a well-defined context (at home) vs. available anytime (mobile) and experiment with the timing of feedback exposure (immediate vs. next day).

**Acknowledgements**
This work is supported in part by the Erasmus Mundus Joint Doctorate in Interactive and Cognitive Environments (ICE), which is funded by the EACEA Agency of the European Commission under EMJD ICE FPA n2010-0012. We would like to thank Emilia Barakova and Huang-Ming Chang for their constructive feedback and helpful suggestions.

**References**