Colour Coding the Fridge to Reduce Food Waste

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ABSTRACT
This paper introduces the first iteration of a study aimed at grouping similar food types together in a refrigerator to increase the awareness of available foods for consumers in a domestic environment. The goals of the project are twofold: i) Raise the awareness of available foods for all members of a household; ii) Reduce the amount of expired food waste in the household. The project implemented a paper-based colour scheme in refrigerators in households, assigning colours to particular food types (e.g. green to fruit and vegetables, red to meat, etc.). The findings show that the colour coding raised participants' awareness of available food items in the fridge, particularly for those participants who were not directly involved in the shopping and initial storage of each food item. The findings also indicate that such awareness led to a reduction in expiration of food and thus general food waste in the household. These preliminary findings suggest that raising awareness of food availability through categorisation and efficient communication of this information may lead to a reduction in food waste in domestic environments.

Author Keywords
Food waste, consumer behaviour, colour coding, human-computer interaction, domestic technologies, urban informatics.

ACM Classification Keywords
H5.m. Information interfaces and presentation; Human-centered computing → Field studies; Empirical studies in HCI; Empirical studies in interaction design;

INTRODUCTION
Currently in Australia alone, households throw away over AU$5 billion worth of food annually, and this represents approximately 40% of total household rubbish (excluding recyclables and garden waste) (Catchlove, 2010). This has, in some cases, severe repercussions for the environment in the form of both a greenhouse effect and land real-estate occupation (Wang, Odle III, Eleazer and Bariaz, 1997). Additionally, Schneider (2008) argues that on average, globally, around 25% of the available food supply is wasted. These wastages happen along the supply chain with a significant portion of the losses occurring in the household and food retail outlets (Kantor, Lipton, Manchester and Oliveira, 1997; Schneider, 2008). Specifically in households, Kantor et al. (1997) found that the majority of the waste comprised food that had been forgotten and expired in the refrigerator or pantry. This is a growing problem that needs to be addressed.

An additional issue governing much of the consumers' behaviour when purchasing food is the conceptual disconnect from food production. Industrial commodification has led to food being more affordable than it used to be in the past. Especially younger people are often not overly concerned about ensuring to consume all the food they have purchased before it expires, and therefore tend to readily throw out expired unconsumed goods (Hill and Lynchehaun, 2002; Padel and Foster, 2005). Further, the food that is thrown out adds to the waste accrued through the entire food supply chain. Expired food waste is prevalent in developed nations and causes significant methane gas production from rotting.

Schneider and Obersteiner (2007) suggest that the behaviour that leads to the prevention of household food waste is determined by several factors including (but not limited to): age, income, and time spent at home. In addition, situational conditions are also argued to influence particular behaviours that may lead to food waste, such as smell, appetite, desire for food and marketing or advertising of a specific product (Lebersorger, 2008; Schneider, 2008). Schneider (2008) proposes several methods of food waste prevention that can be integrated into households. They include using a shopping list, using highlighted tabulated measurements for rational food portion sizes, education in creative uses of food residues, education about the equivalent monetary value of wasted food items for a given consumer, and general food waste awareness training (Schneider, 2008). These outcomes represent opportunities to be integrated into a human-computer interaction design intervention.

There are some underlying issues with the functionalities of modern refrigerator design leading to behaviours that cause a higher risk of producing expired food waste. The issues may not be inherent to fridge design itself, but rather a combination of several factors, stemming from consumer behaviour, the perceived value of food, time-poorness in many households, as documented in a number of studies (Calderon, Iglesias, Laca, Herrero and Díaz, 2010; Levy, 2012; Schneider, 2008). The fundamental problem that the combination of these elements causes is the stockpiling storage behaviour, which causes items in the fridge to get pushed to the back and be no longer easily visible by members of the household and often to be forgotten about until a regular blitz or spring clean of the refrigerator takes place.

In addition, when any member within a household opens the fridge, they are often presented with various food types in a number of different locations. Many

households develop their own – principally tacit – system of organisation whether it be ordered or chaotic. These circumstances were identified to be a problem factor. In recent years, there have been increased discussions about how technology can be used to influence behaviour change within the domain of HCI. This paper explores such an opportunity. The following sections of this paper will present the methodology, findings to date, and discussion from a study that aims to increase the awareness of available foods for consumers in a domestic environment. The paper will conclude by looking at the limitations of the study and its potential future developments.

PRIOR RESEARCH WORK

This paper is based on a mixed-method study that was conducted as part of a three-year PhD project, which explores HCI design opportunities to reduce food waste in Australian urban households. The study promotes healthier and more environmentally sustainable food practices by promoting more efficient purchasing and storing of food, as well as general management of food waste in everyday life. As part of the project, a study was conducted to explore a person's awareness of available food within the context of a shared household (3+ people), a couple household (two people), and a family household (a couple with children). This study builds on a previous study also undertaken as part the PhD project that identified the key factors for behaviours that yield expired food waste in each of the aforementioned households. This study found three major factors and two minor factors for behaviours that result in expired food waste. The three major factors:

- ***Transparency*** (an individuals' forgetfulness or memory concerning the food they have placed in or taken out of the fridge / freezer / pantry);
- ***Awareness of available foods*** (an individuals' knowledge of food items available in the fridge / freezer / pantry for consumption);
- ***Misled / incorrect tacit knowledge*** (the tacit knowledge of an individual who knows if a product with or without an expiry date is edible or not by the use of sight, smell and / or touch).

The two minor factors include:

- ***Unplanned events*** ('spur-of-the-moment' situations that led to a cancellation of a previously planned consumption of food that was purchased for that specific meal);
- ***No desire to consume leftover food*** (a person having cooked a large meal with the intentional goal for the meal to last several consecutive mealtimes, but does not resume desire to consume the leftovers before they go off).

This study responds to the problem factor of ***awareness of available foods***. The study specifically focuses on designing an intervention within the context of the household refrigerator, because the previous study found that this location contributed to the majority of expired food waste, as compared to the pantry or freezer. This study actively engaged consumers by encouraging them to think about where they place items of food in the refrigerator by organising the different food items into clearly defined areas, where each food type is represented by specific colours.

The research premise of this study is: *Does the organisation of a colour scheme for different food types in a household refrigerator raise the awareness of available foods for all members in the household and does this consequently lead to a reduction in expired food waste.*

METHODOLOGY

Guided by a user-centred design approach, members of households were recruited to participate in this study from responses received to an online survey conducted as part of the previous study disseminated to everyday Australian grocery consumers and through the social networks of the researchers.

Seven households were recruited for this study: Four couple households, two family households with 1 and 2 children respectively, and one shared household comprising three people. Recruited members of households represented a spread across a range of demographics. Their occupations included a range of full-time roles in private and public sectors; full-time and part-time students; and full-time stay at home parents. Full-time workers represented the majority of participants and were often busy people. Our screening survey revealed that participants differed quite significantly in their shopping frequencies and the places they shopped for food (this included local food markets, IGA, Coles, Woolworths and local grocers). A small portion of the participants purchase food knowing exactly what they planned to eat the following week (until their next shop), whereas other participants would purchase 'opportunity' food that they thought they might like to eat throughout the week or what could be used in meals. Participants were located across South-East Queensland, Australia.

The study took place over a four-week period. The first two weeks were used to gauge the average quantity of expired food waste produced per week. Participants were encouraged to either write the product name and quantity in a journal or take a photo of product that they threw away to assist in this process. At the end of the second week, the colour code scheme (described below) was implemented and the study continued for a further two weeks to gain insight into how the system was used and its effectiveness in reducing food waste. All participants were asked to customise their preference for which colours would correspond to each food type.

Interview protocols and visual ethnography (Pink, 2007; Schwartz, 1989) were used as qualitative data collection methods. Informal interviews were conducted once a week at the participants' houses. Emergent themes were derived from the qualitative analysis of the interviews. Questions were directed at a household representative who was chosen by all household members. Questions related to four main areas:

- The quantity of food from the fridge, which had expired that week;

- The level of difficulty which participants' had in locating food items in the fridge;
- Had the colour code scheme influenced their shopping patterns in any way;
- Any difficulties or barriers experienced by participants' from using the colour code scheme.

At each interview, photographs were taken of the refrigerator (by the researcher). The photos were a mechanism to not only view the movement of food within the context of the refrigerator and to view participants' engagement with respect to the colour code scheme, but also corroborate what participants' were stating in their interviews. In addition, participants were encouraged to either take a photograph or write down a list of all expired products that were thrown away each week and the quantity associated with that product. This was to assist in gauging the quantity of expired food waste in order to see whether the colour code scheme provided an impact on expired food waste.

A formal debriefing interview was conducted at the end of the study, which all members of the household were involved. This interview covered the experiences of all participants involved in the study. The formal interview protocol comprised of five main questions, each intended to provide insight into: participants' thoughts and experiences with the colour-coding scheme, longer term practicality, impact on participants' awareness of food items, possibilities for technology integration, and thoughts on how intensive they found their participation.

Colour Code Scheme

The colour code scheme entailed using seven different coloured pieces of opaque plastic that were matched (by the participant) to a corresponding food type. The different food types available for a participant to select from included: *Fruit and Vegetable Produce, Dairy, Condiments, Meat, Bread/Baked Goods, Drinks, and Leftovers*. The different food types were determined by results from the aforementioned previous study that showed that participants tend to conceptualise the items in their fridge into groups similar to their grocery shopping experience. The coloured sheets of plastic were cut using common household tools and blue tack was applied to the sheets to ensure they would stick to the shelves of the fridge for the duration of the project. Refer to Figure 1 that illustrates the colour code scheme applied to one participating households' refrigerator.

Figure 1. The Colour Code Scheme applied.

Finally, a 'map' was drawn up of the configuration and printed on an A4 sheet of paper, then stuck to the front of the fridge. This was so any member about to open the fridge door would know in which direction to look for the food type they were after. Participants were asked to customise the colour scheme and change the colour scheme as they saw fit over two weeks. Figure 2 shows an example of the map of the colour code scheme applied in Figure 1.

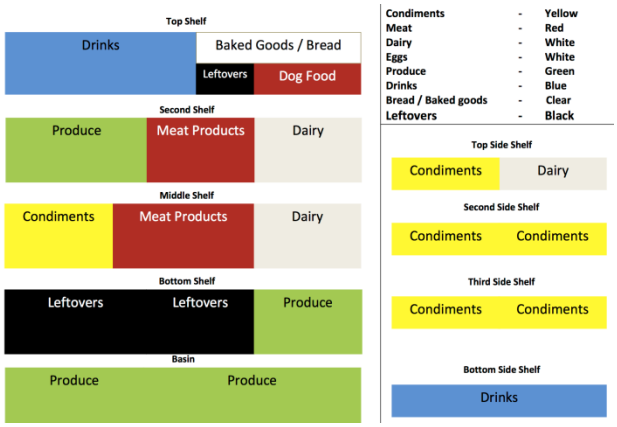

Figure 2. A colour coded map of the interior of an example refrigerator.

RESULTS AND DISCUSSION

Key themes were derived from the preliminary findings of this study which are now discussed in turn.

The Colours of Food

An unexpected finding from the study showed how participants link particular colours to certain food types. Although participants were given the option to choose the colours that they felt best corresponded to food types, they assigned the same colours to the same food types: Green for Produce, white for Dairy, yellow for Condiments, red for Meat, clear for Bread/Baked Goods, blue for Drinks, and black for Leftovers. This assignment of colours to food types might represent a recognisable choice for many. However, a deeper analysis might reveal linkages between contemporary food marketing and people's perception of colours in relation to food types. Given that this study employed a relatively small sample pool, this theme needs further exploration.

Impact on the Awareness of Available Food

The main dilemma currently leading to expired food wastage in households is that not all household members have knowledge of available consumables in their fridge at a given moment. This is because, within a household, there would generally be a primary purchaser of food who often solely arranged the food for storage. This realisation came from the informal interviews that were conducted with participants and cross referenced with findings from a previous study. The lack of food interaction during the purchasing or storage of groceries prevented other household members to gain actionable knowledge of foods available in the fridge. This can also be applied to members who may not reside in the household and instead, who may visit and still require use of the refrigerator. They would be able to see the 'map' enabled by the colour code scheme on the front of the fridge and

generally know where to look for particular items of food when the fridge door was opened.

Weekly interviews revealed that the colour coding had led to a significant increase in participants' awareness of the foods they had available in their refrigerators. This was more so the case with family households or couple households who both held full-time positions. However, all households showed a noticeable increase in awareness. Several participants mentioned this was because of two underlying factors. The presence of the colour schemes required participants to frequently look at the colour-map because the memory of what colour corresponded to what food type dissipated the less frequently used a colour code was. This process continually refreshed their memories about the location of food types in their fridge. Once participants became used to the colour code scheme, they no longer used the map.

The second factor mentioned by participants was that the colour code scheme helped them find items of food more quickly than usual. In addition, the participants in turn suggested this reduces their overall effort to retrieve food. One participant said, "This process works. I've only thrown away one lemon this week." In comparison to their previous weeks (without the intervention) expired food waste had noticeably fallen. The difference in the amount of food waste varied amongst participants, but on average, each household cut their expired food waste production by at least a quarter to a half of what they had previously produced. These initial findings will need to be cross examined and with the final debriefing interview protocols and the photographs taken through the use of the visual ethnography measurements to explore the significance of these factors and to either confirm or disprove them.

Effectiveness in Reducing Expired Food Waste

This study's intention was to promote reduction of expired food waste by increasing the awareness of available foods for everyone residing in the household in question. The preliminary findings indicate that because there has been an increase (a significant increase in some households) of available foods in the fridge of a household, participants became more conscious of the food they could eat. Moreover, they became more conscious of when particular foods would expire than before the colour code scheme was implemented. The preliminary findings showed that participants were consuming more of the food they had purchased and became more active in their pursuit to minimise the amount of food that would expire in the fridge. The informal interviews provided insight into the different motivations for such pursuits. Several participants mentioned that the study itself caused them to become more conscious of their actions, while others mentioned monetary, social, and environmental motivations. Overall, the preliminary findings suggest that use of the colour code system leads to a reduction in expired food waste. Further exploration and analysis are required in order to obtain the extent of the impact the Colour Code Project has in raising the awareness of available foods for all members of a household and in return reducing the amount of expired food waste in the household for a significant period beyond their participation in the study.

CONCLUSION

This paper has presented the preliminary findings of the first iteration of the Colour Code Project. The findings suggest that using the colour code scheme in the refrigerator reduces the amount of expired food waste in households by increasing the awareness of available foods in the refrigerator for all members in a household. Further research is required to explore the additional and longitudinal impact of the colour code scheme – for example, running it in larger households to see if the children of a household are able to effectively adopt the colour code scheme, despite the height disparity. The next step in this research is to understand the interactions that people have not only with the colour code scheme, but with other household members (including interactions grounded by social and cultural norms). Understanding these interactions will shed insight into the human-computer interaction requirements that are needed to be imbedded within the design of current household or personal technologies in order to better facilitate a change in people's behaviours within the household that will lead to a reduction in expired food.

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REFERENCES

Calderon, L., Iglesias, L., Laca, A., Herrero, M. and Díaz, M. The utility of Life Cycle Assessment in the ready meal food industry. *Resources, Conservation and Recycling* (2010).

Catchlove, J. *From plains to plate: The future of food in South Australia*. City, (2010).

Hill, H. and Lynchehaun, F. Organic milk: attitudes and consumption patterns. *British Food Journal*, 104, 7 (2002), 526-542.

Kantor, L., Lipton, K., Manchester, A. and Oliveira, V. Estimating and addressing America's food losses. *Food Review*, 20, 1 (1997), 2-12.

Lebersorger, S. *Abfallaufkommen aus Mehrfamilienhäusern*. VDM Verl. Müller, (2008).

Levy, A. J. Wasteful Food Consumption: Consumer Trends in Food and Packaging Waste (2012).

Padel, S. and Foster, C. Exploring the gap between attitudes and behaviour: Understanding why consumers buy or do not buy organic food. *British Food Journal*, 107, 8 (2005), 606-625.

Pink, S. *Doing visual ethnography: Images, media and representation in research*. Sage, (2007).

Schneider, F. Wasting Food: an insistent behaviour. *Proceedings Waste: The Social Context*, 8 (2008).

Schneider, F. and Obersteiner, G. *Food waste in residual waste of households*. City, (2007).

Schwartz, D. Visual ethnography. *Qualitative Sociology*, 12, 2 (1989), 119-154.

Wang, Y., Odle III, W., Eleazer, W. and Bariaz, M. Methane potential of food waste and anaerobic toxicity of leachate produced during food waste decomposition. *Waste Management & Research*, 15, 2 (1997), 149.