Maryland Institute College of Art | UX Design MPS | Research Thesis

Designing to Reduce Household Food Waste:

Discovering Solutions to Reduce American Consumer Carbon Emissions

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PROJECT OVERVIEW

Introduction and Significance

Reducing household food waste is one of the most tangible ways in which consumers can directly reduce their long-term environmental impact. While for some consumers it is easier to recognize the waste that is created by earlier phases along the food supply chain, like production (farms) and distribution (grocery stores), it is easy to misunderstand and miscalculate the cumulative impact at the consumption stage. A global study conducted by the Food and Agriculture Organization of the United Nations revealed that in 2011, household food waste contributed to 37% of the total carbon footprint that occurred along the food supply chain, which was more than the impact of production and distribution combined ("Food Wastage Footprint & Climate Change"). This equated to 8% of the global greenhouse gas emissions and little has been done to reduce this impact.

Unfortunately, there is a disparity between actual and perceived food waste for the average American household. A recent study focusing on American household food waste concluded that the average US household wastes about 31.9% of their food on a yearly basis, which equates to roughly $1,866 per household a year (Yu and Jaenicke). On the other hand, another study from Ohio State University discovered that consumers believe they consume sometimes up to 45% more of their food than they actually do (Davenport et al.).

The complexities of climate change and household food waste cannot be understated. While some researchers suggest that a lack of meal planning and food management are core factors leading to increased waste (Yu and Jaenicke), other studies point to ambiguous expiration

labels being one of the largest areas of concern (Davenport et al.). Many circumstances must be taken into account, including household size, income level, diets, schedules, and cultural differences (Wahlen and Winkel). Understanding the complexities of current consumer behavior is key to identifying effective opportunities for design solutions.

Conceptual Framework

This research project is driven by the dire need for American consumers to focus on their environmental impact. North American consumers currently have the largest per capita food waste carbon footprint compared to other regional contributors ("Food Wastage Footprint & Climate Change"). While climate change is a large and complex issue that will require improved efforts from numerous sectors, diminishing household food waste is one way consumers can have a noticeable effect on reducing global carbon emissions. My research focused on understanding current food waste behaviors in order to create new solutions to help households better manage their food waste.

Problem Statement

How might we design a solution that merges the desire to be eco-friendly with effective means of changing user behavior in order to encourage American households to sustainably reduce their food waste?

Hypothesis

American consumers waste food despite having negative feelings about their food waste because they need personalized information about their environmental impact and positive emotional feedback to motivate them to change their behavior.

Scope & Research Questions

To better understand user motivations and pain points towards reducing food waste as well as potential effective solutions, I based my research methodology on three questions:

1. *Why do people want to reduce their food waste?* Understanding consumer motivations will help us understand their current mindset so we can better design a solution that encourages long-term change.
2. *What emotional feedback incorporated into a design solution can inspire long-term, sustainable behavioral change to help consumers reduce their food waste?* Incorporating an emotional and compassionate approach to the solution will be key in both connecting with the user and encouraging long-term behavioral changes.
3. *What information are users interested in seeing about the impact of their food waste?* Understanding what information and data households value will help me optimize a solution that provides transparency in personalized food waste contributions.

Pre-Research Assumptions

- American consumers are interested in reducing their household food waste to reduce their negative environmental impact.
- Consumers are interested in knowing how their actions translate to direct environmental impact (ie: how many trees they saved by reducing their carbon emissions).
- User research will reveal the core issues consumers face when it comes to managing their food at home.
- A mobile app would provide one of the most convenient delivery methods for the final solution concept.

RESEARCH METHODOLOGY

Research Design & Activities

The research design for this project was broken into the following four components:

Academic Research

I consulted numerous academic sources regarding effectively designing for behavior change and emotional responses. This included Dr. John Whalen's *Design for How People Think*, Aarron Walter's *Designing for Emotion*, and Dr. Stephen Wendel's *Designing for Behavior Change.* Since decision-making regarding purchasing, preparing, and consuming food is often an automatic behavior that people put little thought into, it was key to understand human psychology and how a design solution can effectively mesh into existing consumer lifestyles.

Competitive Research

To understand what other companies are doing to reduce household food waste, I analyzed 33 apps and websites within the food waste industry. For each competitor, I defined their method of food waste reduction and evaluated the strengths and weaknesses of their user experience.

Exploratory Research - User Surveys

This first round of user research was focused on exploring household food waste trends at a high level to understand the scope of the issue, analyze trends, and identify opportunities for solutions. This research consisted of a survey that contained 30 questions focusing on the user's demographics, shopping behaviors, cooking behaviors, and food waste behaviors. Results were collected via various social media sources, including Facebook, Snapchat, and Reddit. 110 responses were recorded.

Concept Research - User Interviews

I conducted concept research with 6 participants via a remote video call to gather insights from target users on their current routines and discuss motivations regarding food waste. Interviews lasted approximately one hour each and focused on the consumer's lifestyle and frustrations. I concluded each interview with a card sorting activity, where participants were asked to rank their favorite design concepts and discuss their decisions.

Limitations

Response Bias

By sharing a survey regarding food waste, it is possible that participants were more likely to complete it if they were already interested in the topic. This bias may skew the results and not represent the average American household.

Social Media Reach

Recruiting for research via social media was complicated and delayed both rounds of user research. Various Reddit subreddits required prior approval before posting any material for research purposes, which added a few days to the research timeline.

Participation Risk

My request to share my survey in some environmental Reddit threads was denied by moderators since they could not guarantee participant anonymity. This exposed to me the dangers environmental activists often face abroad, including the risk of murder. As a result, my recruitment focused on low-risk participants, which limited my participation pool.

Issue Complexity

American household behaviors are complex and difficult to analyze due to diverse lifestyles, structures, cultures, and interests, among other factors (Wahlen and Winkel**)**. It would be extremely difficult or even impossible to design a single solution that would help all US

households reduce food waste. Focusing on larger key issues and a smaller user subset would be critical for this design.

RESULTS

Academic Research

The academic resources referenced helped frame the approach I took for the following phases of research. Key takeaways from academic research included the following:

1. Human decision making can be broken into rational thinking, which is our conscious deliberate thinking, and emotional thinking, which is our intuition and habits. In the instance of food waste, there is a separation between a person's rational thinking (ie: to save money and improve the environment) and their emotional thinking (ie: their current habitual routines and lifestyle) (Wendel 3).
2. The key to long-term sustainable behavior change is to condition consumers to create new habits when responding to a cue. For instance, when a person is hungry (their cue), their current conditioning may lead them to first think about ordering takeout. An effective design should help recondition the user's thinking to a new response, such as checking what is in their fridge before considering takeout (Wendel 48).
3. Users are reward-driven. By providing a reward to a change in behavior, it helps merge this new routine into their emotional thinking so users begin to associate it with positive feelings (Wendel 10).

4. Incorporating personality and delight into a design will also help users associate their behaviors with the positive feelings experienced within the design solution. This increases the likelihood of repeat behavior (Walter 28-29, 47).
5. Visual popout is an effective way to redirect a user's attention during their autopilot routines, especially when the object provides sufficient contrast to other objects in its environment (Whalen 14-16).

Competitive Research

Attempting to reduce household food waste is not a novel idea, but no current solution has been effective enough to have a wide-scale impact. To understand competitors in this space, I reviewed both digital solutions and physical products. After compiling a list of leading solutions, I analyzed their strategy to reduce food waste and their strengths and weaknesses from a user experience perspective.

Digital Solutions

During my research, I identified 29 leading global mobile apps specifically designed to reduce food waste and help consumers make more sustainable decisions. This included apps such as Food for All, Food Rescue US, Goodr, Impact Vision, Karma, UGO Fresh, and YumNow. Of the apps analyzed, I identified 12 unique methods to reduce food waste, with the following approaches being the most common:

1. Support food charities via donating food surpluses from restaurants or households
2. Reduce restaurant food waste by selling surplus and expiring food at cheaper prices

3. Reduce grocery store food waste by selling surplus and expiring food at cheaper prices

Some applications took other unique approaches, such as farm to table food sales, connecting consumers to share their extra food with their community, and apps that allow consumers to scan barcodes of items to evaluate the company's ethical ratings. However, mobile apps with these strategic approaches towards food waste were less common.

Leading food waste websites, including Save The Food and Eat Or Toss?, generally had more features than their mobile app counterparts, and were more focused on educating the consumers on food expiration and providing recipes to reduce food waste. Across all apps and websites, I identified the following UX strengths and weaknesses for these solutions:

Strengths	**Weaknesses**
● Provide improved logistics to connect consumers to expiring food ● Reduce waste for grocery stores and restaurants ● Reduce phases in the food supply chain by connecting consumers to producers ● Provide education to consumers regarding food freshness ● Help consumers make cooking decisions via suggesting recipes ● Support charities by connecting surplus food to needed areas ● Allow consumers to track their current inventory and expiring foods	● Many leading apps are restricted to specific countries or regions and are not accessible at a national level ● Small user bases in some apps make it difficult to connect to local consumers/stores/restaurants and effectively use the features ● Some apps are outdated and no longer supported, making them obsolete ● Inventory tracking apps require a lot of manual effort to use and maintain ● Most apps focus on waste from restaurants and stores but do not help consumers manage their household food, where most waste occurs

Product Solutions

Silo and Ovie are both household products that help consumers track their food and their freshness level. Silo, a Kickstarter product, is a vacuum sealer that uses proprietary containers. Consumers can seal their foods and add the item's name via Amazon Alexa, which then tracks the freshness of the contents and usage to alert users of reordering ("Silo"). Ovie, a similar product, utilizes digital Bluetooth tabs that users can place on their containers. Via Amazon Alexa, users can add the food item to track its expiration via the Ovie database and the tabs change colors to indicate the freshness ("Ovie Smarterware"). Both products aim to provide visibility of food expiration and, for Silo, extend the lifetime of food products.

Smart fridges, although not very new to the market, have not been largely adopted by American consumers yet. These fridges have a large touchscreen inserted in the fridge door that allows users to engage in numerous activities ranging from viewing recipes to checking their Twitter feed. Most models allow users to track their food inventory to help provide visibility of the contents. While most focus on the touchscreen functionality, some models include barcode and RFID scanners to simplify logging products ("LG ThinQ Smart Refrigerator").

The final product I reviewed, Winnow, is a solution tailored for restaurants. This product utilizes a camera and AI technology to record and analyze how much and what kind of foods are wasted in the restaurant business. By measuring waste over time, this product tracks the waste to make purchase recommendations to the restaurant. Through automating this process and adding visibility to the waste, Winnow states that restaurants using their technology save an average of $35,000 a year ("Winnow").

While most of these products serve to reduce household food waste, a big disadvantage they face is their pricing. Both Silo and Ovie are sold for high costs, making them unattainable to the average consumer. Silo's Kickstarter sold its base and four containers for $179. Similarly, Ovie is selling their starter kit, which contains trackers for three food items, for $130. The average consumer would likely need at least double the number of containers and trackers than these kits provide. At this price point, it can be difficult for consumers to rationalize purchasing, especially when they can purchase vacuum sealers for $20. Even if these products are effective, the disconnect between the business goals and consumer pricing needs is problematic.

Key Takeaways from Digital and Product Solutions

- Many mobile apps are restricted to specific countries or cities and have small user bases, which makes them less effective in reducing the overall impact of food waste.
- Most digital solutions were more focused on grocery and restaurant waste than helping consumers manage household waste.
- Most food management apps focus solely on inventory rather than connecting the user's food waste behavior to their environmental impact.
- Inventory management apps and products require a lot of manual effort to maintain, which makes consumers less likely to use them long term.
- Products like Silo and Ovie provide a more seamless user experience by including Amazon Alexa but are priced too high for the average American consumer.

Exploratory Research

Over the course of one week, I collected survey results from 110 participants across varying social media platforms, including Facebook, Snapchat, and Reddit. Questions were designed to understand the participants' demographics, shopping behaviors, cooking behaviors, and food waste behaviors. Despite containing only a few required questions, each participant answered a majority of all questions in the survey. Via analyzing the results, I was able to identify the following trends:

- 89% of participants responded 'Yes' to 'Are you interested in reducing your food waste?'
    - Individuals with annual household incomes over $100,000 or below $50,000 were more likely to say 'Yes'
- A majority of participants stated they feel negative emotions when wasting food, ranging from "annoyed" to "disappointed" to "guilty."
- Individuals with a household income of less than $75,000 were more motivated by the financial loss of food waste than environmental causes.
- The most commonly wasted food items included, starting with the most wasted: leftovers from previous meals, produce, and meat.
- The leading reasons households with incomes $75,000 and less wasted food included the following:
    - Produce comes in too large quantities and they do not manage it properly
    - Forgetting what is in the fridge
    - Overbuying groceries and not consuming it all before expiration
    - Choosing to go out to eat while they have food at home

When given the opportunity to reflect upon their answers and behaviors, some consumers had the following information to provide:

- *"If refrigerators were smaller people wouldn't forget about the stuff way in the back."*
- *"In addition to a "sell by" date there should be a "use by" date. The "best by" date is pretty useless."*
- *"Ultra super smart fridge."*
- *"Maybe, a packaging tag that can remind smartphone? What's in your fridge and about to expire food items?"*
- *"i think mindful buying and pantry/fridge organization are the key points"*

Concept Research

I held a remote video call with six participants to understand their current lifestyles relating to food management and dive deeper into their motivations and interests. The interview began by asking participants about their current lifestyles and routines regarding their household cooking and food management. After the interview, I observed participants complete a card sorting activity using Optimal Workshop. Each card contained a unique method for helping households reduce food waste, which were collected from the competitive research as well as my own contributions. Participants were asked to rank these methods from most to least interesting and relevant to their lifestyles and share their thoughts.

Key Takeaways

- Participants were busy but wanted to reduce their food waste. Their time is precious to them and they would not be motivated to make large changes in their routine.
- 5 of 6 participants were more interested in their financial loss from waste than their environmental impact.
- Most participants were interested in managing their food better at home rather than working with another group, such as their community or grocery stores.
- Visibility was the main issue for most participants. Many had food they intended to eat but forgot about it and found it after it had already expired.
- Some participants were not sure how to judge if leftovers expired. This aligns with research findings that show consumers typically lack an understanding of food labeling (Fattibene and Bianchi).
- Most participants who try to manage their food inventory use technology, such as shopping list apps, Alexa for shopping lists, or recipe databases.
- Most participants purchase more than they need because it is more cost-effective to buy food, especially produce, in bulk.

Food Waste Method Response: Community Food Sharing

While individuals living in cities with diverse ethnic communities suggested they would be interested, most participants were grossed out by the idea and showed signs of distrust towards their community regarding food quality and safety.

Food Waste Method Response: Purchase Discounted Foods Near Expiration

Participants were conflicted - while some supported this idea, others were opposed because they did not want to buy bad food and thought they would waste it if it expired quickly.

Food Waste Method Response: Farm to Table Purchasing

Participants generally liked this idea but seemed hesitant about this option because they associated it with high prices. Some participants did not know how this reduced food waste.

Food Waste Method Response: Donating to Local Charities

Most participants were unsure of this option. They thought it would be a lot of work and some felt guilty about donating what they considered to be scraps. One participant who worked in the nonprofit sector said that most food received by charities went to waste anyway and that monetary donations were more beneficial.

Food Waste Method Response: Inventory Tracking

Most participants stated they would likely be too lazy to log their inventory manually but would appreciate knowing what food they have at home. Some have used inventory management apps in the past and said it was too difficult for them to regularly maintain.

Food Waste Method Response: Recipe Suggestions for Home Inventory

All participants responded to this option favorably. Since they had already invested the money in their purchased food, they wanted to make it as useful as possible but were often

uninspired or unsure of how to use their ingredients. However, most noted that manually inputting their ingredients would be too much of a time investment for their busy schedules.

Food Waste Method Response: Reminders

All but one participant stated they would like reminders. Many struggled with forgetting what foods they have at home, and reminders would help them make decisions to reduce waste.

DISCUSSION & ANALYSIS

Domestic Food Waste is Larger than a Single Design Solution

There are diverse and complex cultures around household food waste, which is a primary reason why researchers have struggled to draw conclusions to declare the leading causes. Research has noted multiple factors of influence that consumers encounter on a regular basis, including their household structure, roles, where they source their food, emotions towards waste, and personal definitions of edibility (Wahlen). Unfortunately, these studies fall short in stating what the most influential factors are when it comes to food waste behaviors. Due to the issue complexity, my design solution will focus on food inventory management, which is where user research revealed the largest area of concern to be.

Refocus Lens from Environmental to Financial

Based on the user testing, it was evident that consumers are more interested in their personal financial impact of their food waste than their environmental impact. This is likely driven by their financial status as well as little education on the role of households in global food

waste trends. An effective solution should be relatable to the consumers and therefore help them understand their financial loss. The environmental impact would be a secondary benefit of consumers managing their food waste, although this does not have to appear within the user-facing solution.

Food Management is Key, But Uniqueness is Required

Both Dr. Wendel's research and my user research have shown that food management is a key area where household food waste can be vastly reduced. Unfortunately, many apps exist to help consumers manage their inventory, causing them to establish mental models that the apps are time-consuming to use (Wendel 9). Other products that try to automate the process have largely been too expensive for the average consumer market. A new solution that focuses on food management should be different enough that prospective users do not associate it with the complexities of existing apps and should align with consumer pricing goals.

An Effective Solution Should Minimize Behavior Change

Since meal planning, cooking, and food management are already part of the busy existing lifestyles of consumers, my solution would need to minimize how much a user has to change their behavior to increase adoption of my product. If a solution is too difficult, users will likely abandon it and it will not successfully change their long term behavior. Instead, the solution will need to seamlessly integrate into user lifestyles, utilize machine learning for expiry tracking, and capitalize on existing technologies to provide ease of use for inventory management, such as digital home assistant technologies.

Conditioning Users via Visibility

Behavior change needs to occur through both conditioning and visibility. It will be key to balance being not too obtrusive to existing user lifestyles while also regularly reminding consumers of their food inventory. One opportunity is to design a screen or tablet for consumers to insert onto their fridge, which can be provided at a lower cost than a smart fridge, and would exist in a location that provides visual popout in the user's daily routine (Whalen 14). Additionally, a companion app would add another level of visibility by providing the user reminders of their inventory and recipe suggestions for near expiring foods, which can lead to improved decision making. Machine learning can also be integrated to learn user schedules and trigger reminders at the most opportune times to recondition their behavior, though this might need to be a future feature and not included in the initial MVP.

Emotional Feedback & Rewards are Essential

Providing positive feedback and delightful experiences for the user will be critical for continuous engagement. The feedback consumers receive should provide them feelings of self-gratification for having taken positive steps to reduce their food waste. While tracking a user's environmental impact and financial impact might be too difficult if I intend to automatize their experience as much as possible, an MVP could provide some form of positive feedback to the user for regularly using the product. Further user testing will be required to understand what rewards are most effective, but initial designs will include reminders of how much food and

money is wasted in the United States on average and celebrate consumers that are lessening their negative environmental impact.

CONCLUSIONS, IMPLICATIONS, & RECOMMENDATIONS

Before beginning my research, I approached this topic with the three following questions:

1. Why do people want to reduce their food waste?
2. What information are users interested in seeing about the impact of their food waste?
3. What emotional feedback incorporated into a design solution can inspire long-term, sustainable behavioral change to help consumers reduce their food waste?

Through research, it became increasingly clear that consumers were more concerned about their personal financial loss than environmental impact because they associated throwing away food with throwing away money. Additionally, tracking the impact of food waste would require consumers to track both their inventory as well as their trash, which would require a lot of manual effort that would likely lose user interest. These findings invalidated my assumptions that users were interested in understanding their negative environmental impact from food waste and led to a large shift in my approach to my design.

As a next step, I recommend creating a low fidelity prototype of an MVP to be tested with prospective users. Based on research results, this MVP would include the following:

- A tablet that can be attached to a fridge for users to easily view contents sorted by expiration. Users can use basic features to add or remove items from the tablet. This provides visibility of fridge contents in a location they encounter on a regular basis.
- A companion app to provide an augmented experience, where users can access more inventory features, meal plan, find recipes, and make shopping lists. This app communicates with the fridge and sends users reminders for added visibility.
- Integrate the user's home assistant with the tablet and app to create a more seamless management experience.

Due to the change in approach to my initial design concepts, I was unable to test with users what forms of emotional feedback would be most effective. I intend to incorporate elements from Aarron Walter's *Designing for Emotion* into my MVP designs, such as providing delightful experiences by personifying and personalizing the tablet and app, which I then plan to test with users in future concept and usability testing.

Overall, there is a great need for American households to reduce their household food waste because of the impact on global climate change. Even though this MVP will likely not provide users their personal environmental waste impact, the core purpose will continue to serve a beneficial environmental purpose. User and competitive research has revealed that consumers are interested in reducing their food waste, regardless of their motivation. This proposed MVP would fill existing gaps in the market as it aligns better with user goals and lifestyles while also being available at a price point that is more attainable than current solutions in the market.

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