WastePlacer

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Problem and Solution Overview

In this project, we tackle the problem of waste generated by different households, with a specific emphasis on food items. We found that individuals often do not sort their food and food packaging correctly, which wastes the natural resources used to produce the food item in the first place, and, in the case of recycling, could potentially contaminate the entire recycling bin. We also found that individuals do not have a clear understanding of the sheer amount of waste they throw away every day. Our solution will tackle the problems of incorrect sorting and lack of understanding by helping people sort and track their different types of waste through a smart trash bins. It will feature the three class waste receptacles, along with a screen and camera to assist with sorting.

Correct sorting is encouraged by displaying the current streak of correctly sorted items, as well as the highest recorded streak for extra motivation. If a person is unsure on how to sort an item, they have the ability to capture an image of the item, and the screen will help them figure out the correct placement. After an item is tossed, helpful facts and tips are displayed on the screen to increase awareness. Finally, a household is able to track their data over time, including incorrect vs. incorrect, as well as counts of items thrown into each waste bin.

Initial Paper Prototype

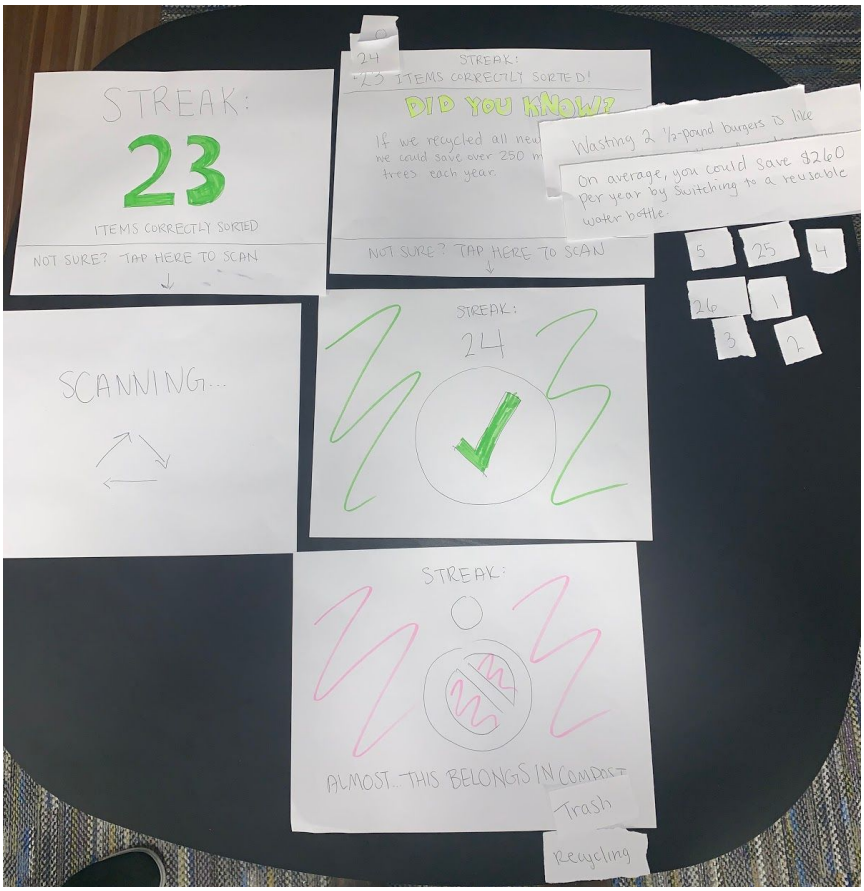


Figure 1: Overview of initial paper prototype

Overview

Our initial paper prototype focused on two main tasks: 1) helping people sort their trash and 2) Giving real world context of their impact on waste, which includes observations and suggestions.

Task 1: Sorting into correct bins

The user attempts to scan their item by holding their item in front of the scanner (Figure 2).

Figure 2: Scanning screen

(At this point in our paper prototype, we forgot the important screen of telling people the correct bin to place the item). Once an item is scanned, the user disposes of the item. If the user is correct in their choice, the screen displays a green check mark (Figure 3) and increments the streak. On the other hand, if the user places the item in the wrong receptacle, the incorrect screen (Figure 4) pops up and resets the streak. It also informs the user of the correct bin.

Figure 3: Correct disposal screen

Figure 4: Incorrect disposal screen

Task 2: Giving users real world context

After an item is disposed, a real world “fun fact” or tip specific to the item disposed is displayed to encourage users to change their waste habits (Figure 5).

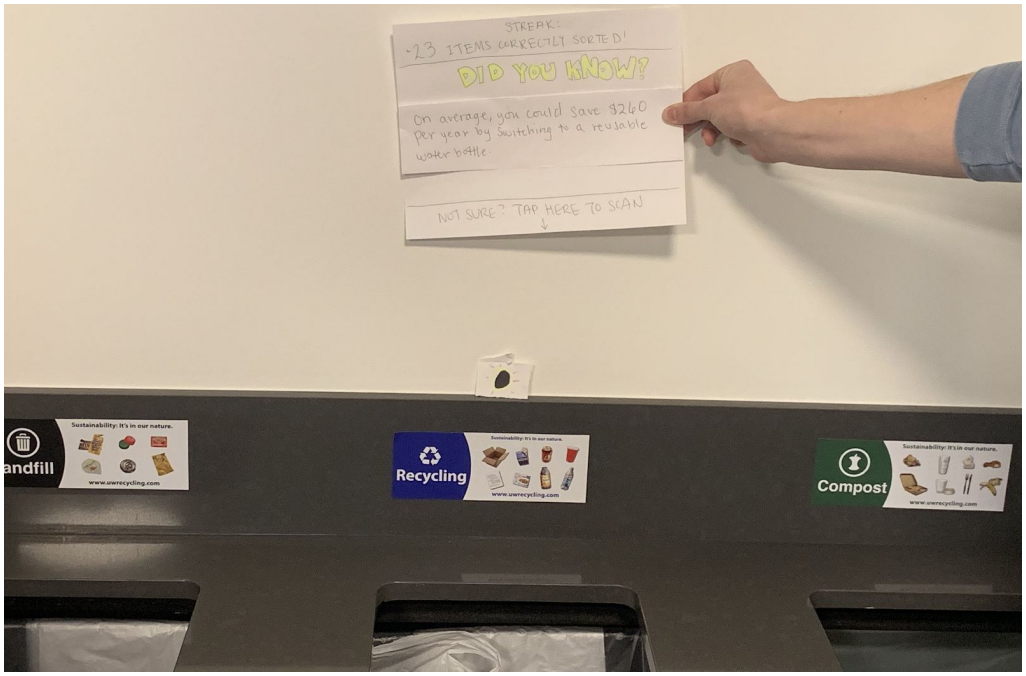


Figure 5: post disposal/tip screen

Figure 6 features other potential tips that we had in our early prototype.

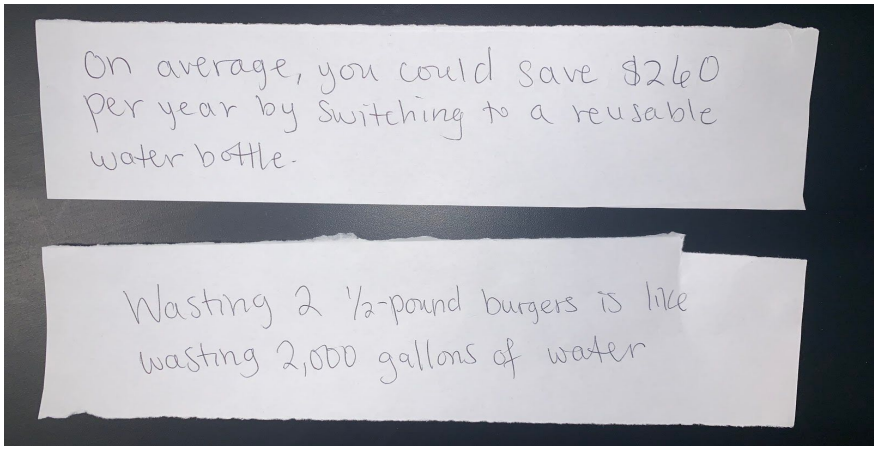


Figure 6: Other tips

Testing Process

For our usability tests, we had participants use our three-bin system with paper held above, representing the screen. They all practiced using the features of scanning an item to find out what bin that item belonged in, throwing away an item in the incorrect bin, and looking at the track feature that came in after the second prototype.

The participant for our first usability test was a roommate of one of the team members, conducted in their apartment. A hiccup that occurred was during the transition between our first and second screen. The first screen displays the streak as the main focus while the second screen, which appears when a person is detected nearby, minimizes the streak number and focuses on a random fact about the environment. The transition between the two never really quite makes sense to the participant until it is explained to them. Therefore, we decided to have the user start out a distance aways from the bin and slowly approach it. We also had a participant throw away a plastic water bottle when the screens were meant for compost, confusing them. Thus, we decided to first specify a few items that the participant could throw away, and our screens matched these items, making the process a lot smoother.

The second usability test was done by a housemate of a group member in a shared house of 21 people. This was done in the kitchen against the wall to simulate where the bins would most likely be in a home. The amount of people in a home was of interest as more waste would need to disposed of. However, each floor would have their own as they each have their own kitchen. This could help the streak feature and would have less people so they might care a little more because they have a larger impact on the streak.

The third usability test used the same paper prototype as the second usability test. This usability test was done by a college female student that lives in a house of 10 individuals. This test also was done in the kitchen against the wall to simulate where the bins would most likely be in a home. With a smaller home it might be more meaningful and could be perceived differently.

Testing Results

After our first usability test, we changed our prototype and shifted our focus from a public bin system to a household bin system. We labelled the different bins with symbols and colors that are indicative of recycling, compost, and garbage, due to user confusion over which bin was which. We decided to have one home screen instead of two as the second one seemed unnecessary. We also added a tip that pops up after an item is disposed, so that the user can see a suggestion that is immediately relevant to them.

Both second and third participants believed that showing the symbol of the bin after scanning an item would be more helpful than words saying which bin it goes in. This would make it more simplified and could be used by most age levels, possibly kids in family homes. Thus, we added in the symbols in addition to the words. Both participants also said that sliding to edit and delete the graphs in the tracking page was not intuitive. There is no indication to tell the user to do that to edit or delete the graphs; therefore, we got rid of the sliding functionality.

The second participant thought that the streak did not have much purpose; however, we decided to keep the streak because other participants thought they were a good source of motivation. He also believed that there could be milestone-like goals that when met could have an animation to have more encouragement from proper waste habits. Once the edit graph is selected he did not know how the format would work with the slider for the time that is shown or further breakdowns of the waste. We then replaced the time-frame slider with push-down buttons similar to the ones found on the fitbit.

The third participant suggested having an edit button on the side which could change the type of graph as well as the time that is shown. We implemented this, but ended up also eliminating it in the end because too much control over the graph appearance seemed unnecessary. They also believed it was easy to use and a nice way of trying to correctly dispose of waste. The scanner was believed to be not obvious, so we made it bigger. The home screen was also squished, so we spaced it out and made the more important aspects bolded and larger in order to draw attention. A cancel button was added to the scanning screen in order to give the user more flexibility and control.

Final Paper Prototype

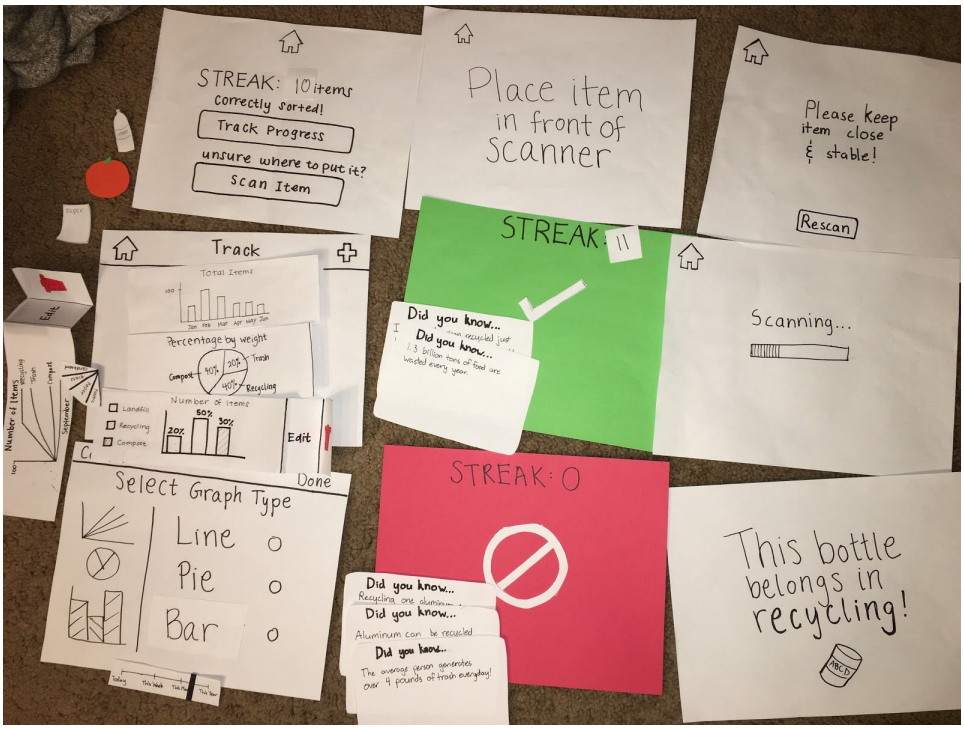


Figure X: Overview of final paper prototype

Overview

Our final paper prototype pivoted from our original tasks a little. While our focus remained unchanged, we put more emphasis on the tracking aspect of the product, adding supplemental graphs and charts for people to visualize their waste habits. We also made changes to give the user more insight (visibility) into what was happening.

Task 1: Sorting

Figure S1: Overview of home

Figure S2: Close up of home page

The three bins: the left is compost, the middle is trash and the right is recycling. The scanner is the dot above the trash, and the home screen above the camera (Figure S1).The home page (Figure S2) indicates the current streak of items correctly sorted, and displays two different options. One is to track the progress of waste disposed, and the other is to scan an item if you are unsure of where to put it.

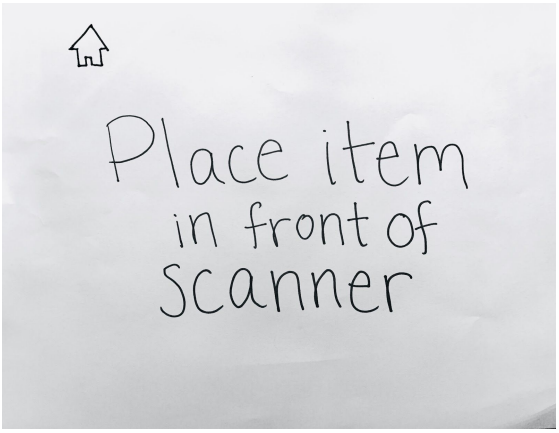


Figure S3: Scanning screen

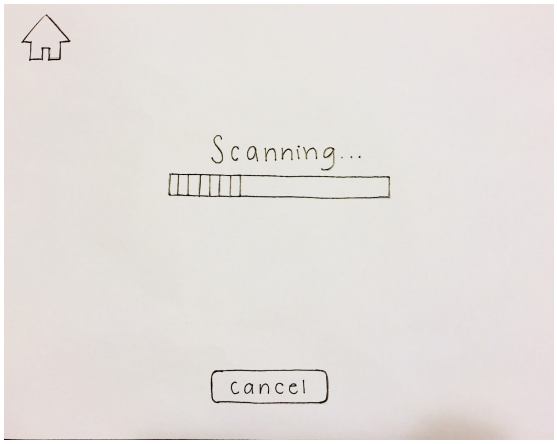


Figure S4: Progress bar

When a user clicks “Scan Item” on the home screen, it takes you to Figure S3. It tells the user to place the item in front of the camera. When an item is detected in front of the scanner, it begins scanning and shows a progress bar (Figure S4).

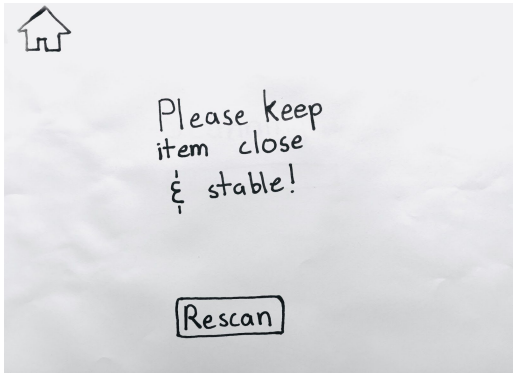


Figure S5: Error page

Figure S6: identification page

One minor change was to improve error diagnosis. If the item is too far away from the screen or keeps moving, an error page pops up (Figure S5). Once the item is scanned and the category identified, the user is notified along with an image of the item (Figure S6).

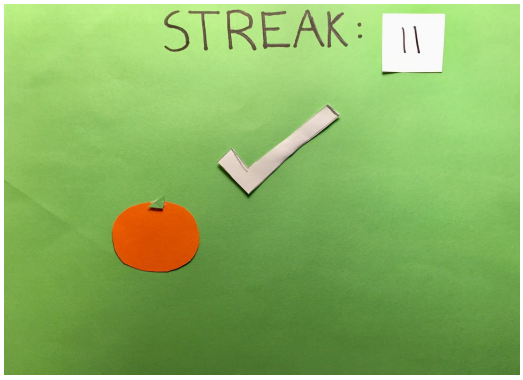


Figure S7: Correctly placed

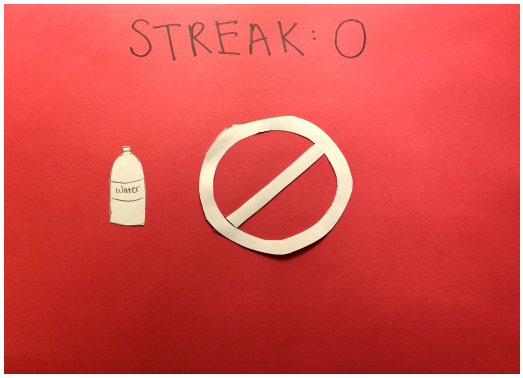


Figure S8: Incorrectly placed

If the item is correctly disposed of, a green screen and incremented streak is displayed (Figure S7). Otherwise the red screen and zero'd streak is displayed (Figure S8).

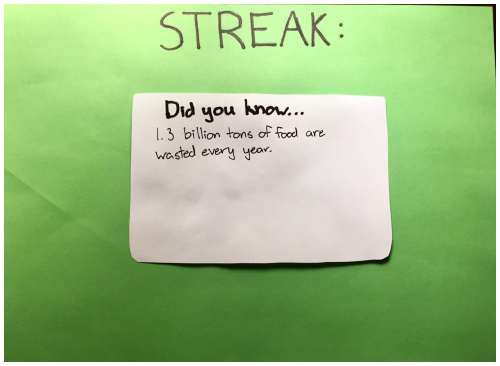


Figure S9: Fact pop up

After a few seconds, a pop-up with a tip or fact appears, related to the item that was thrown away (Figure S9).

Task 2: Tracking

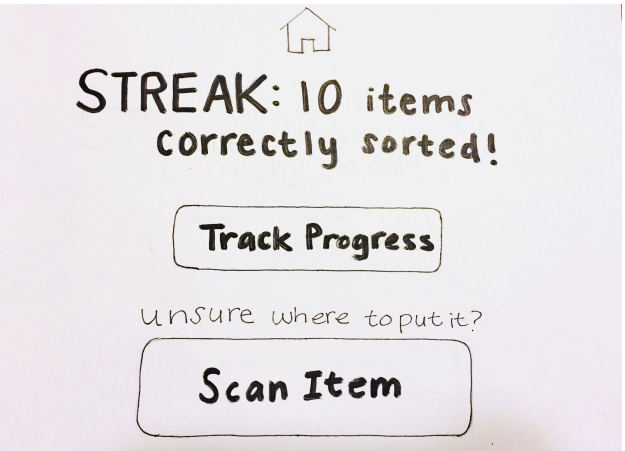


Figure T1: Home page

This was one of the biggest changes we made from the previous prototype. After clicking “Track Progress” on the home page (Figure T1), four default graphs (Figures T2 and T3) pop up. One graphs the number of items disposed of for each category; the second, the total number of items overall; the third, the number of incorrectly vs correctly disposed items; the fourth and last, the breakdown of items by weight. The slider at the bottom controls the time frame in which the graphs are shown; it can be anywhere from the a day to a year.

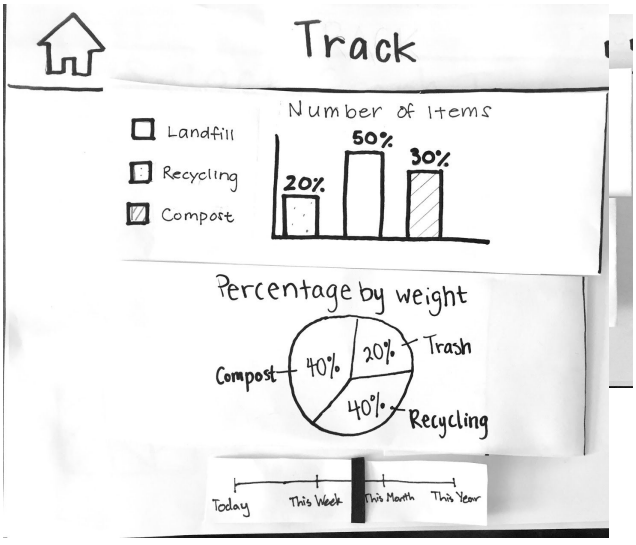


Figure T2: Graph screen

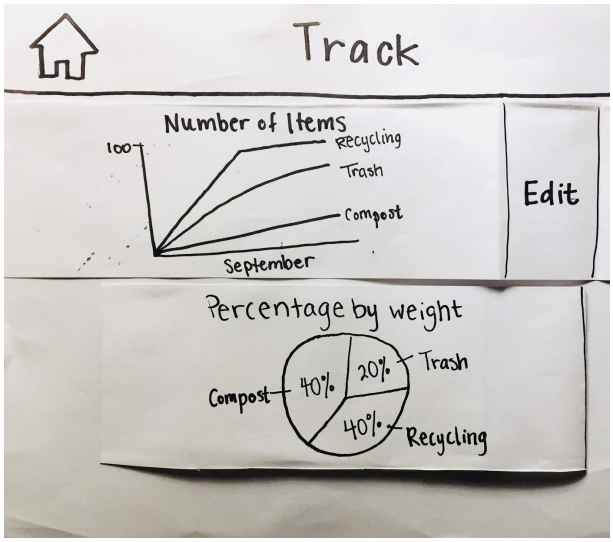


Figure T3: Graph screen cont.

You can edit the graph using the edit button on the side (Figure T3).

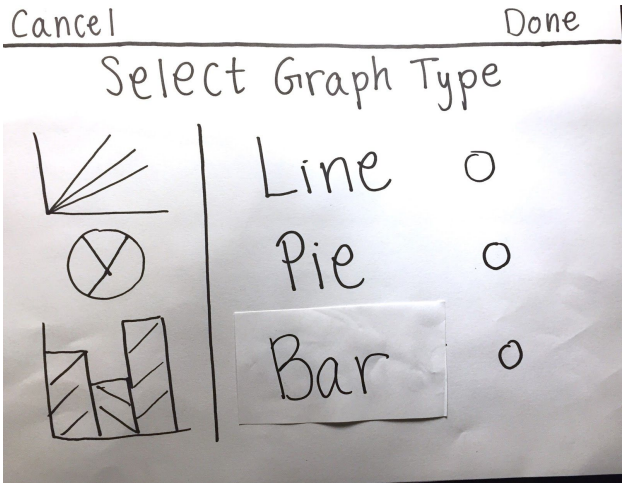


Figure T4: Edit screen

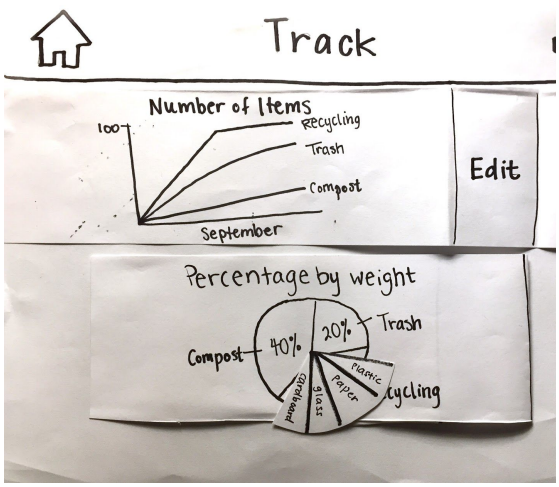
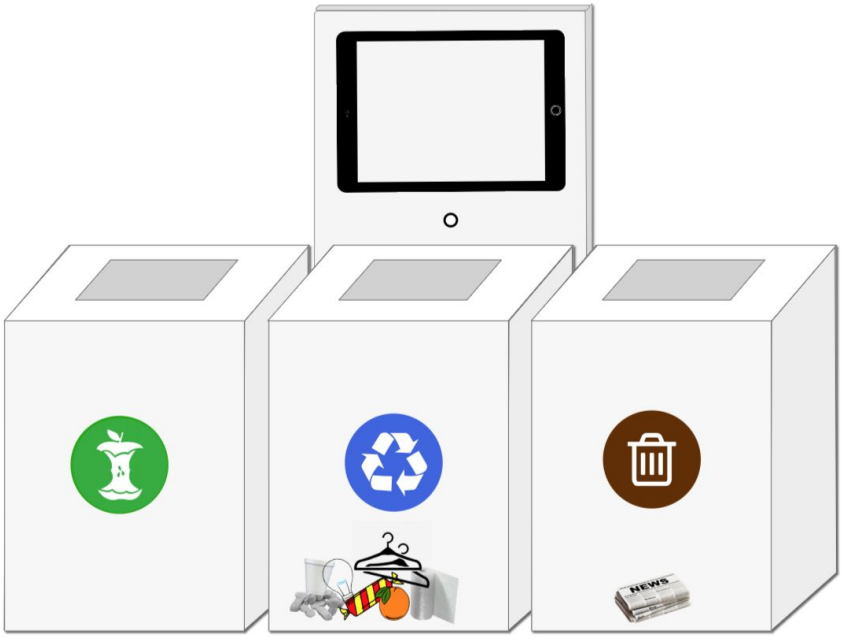


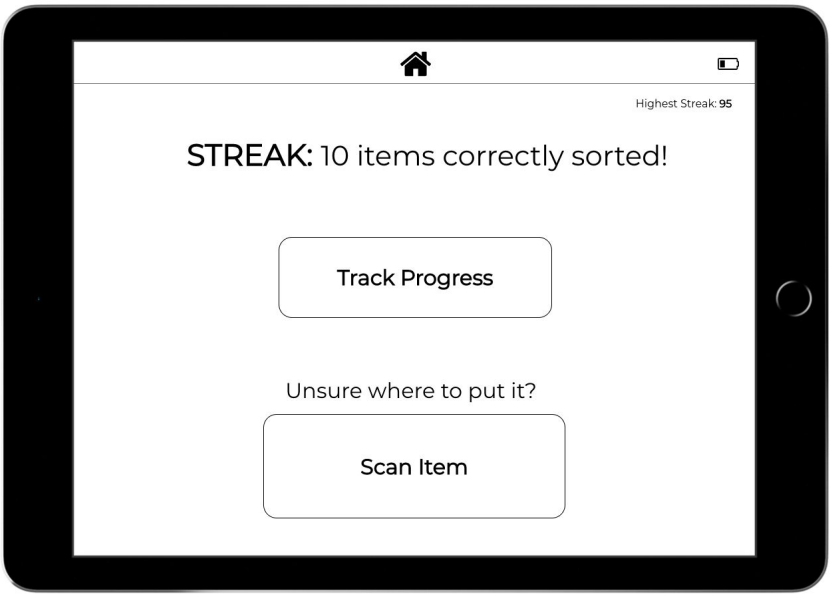
Figure T5: Detailed breakdown

When “Edit” is clicked, it brings up the edit screen (Figure T4), which allows you edit the format of the graph is displayed. Another functionality is if you press down on a certain section, it expands and gives you the more detailed breakdown of the subcategories (Figure T5).

Digital Mockup

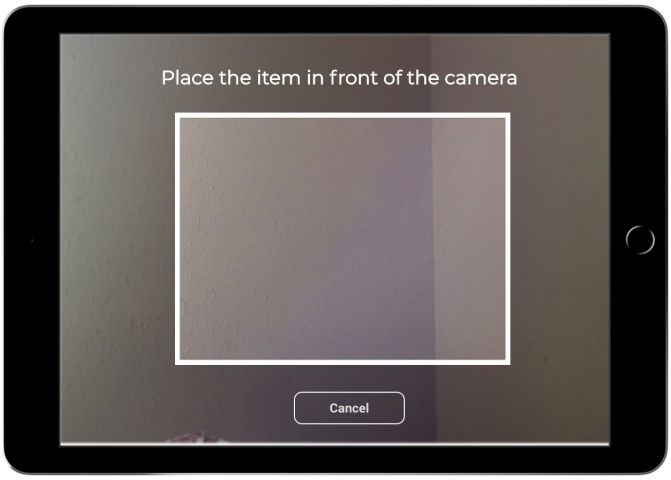


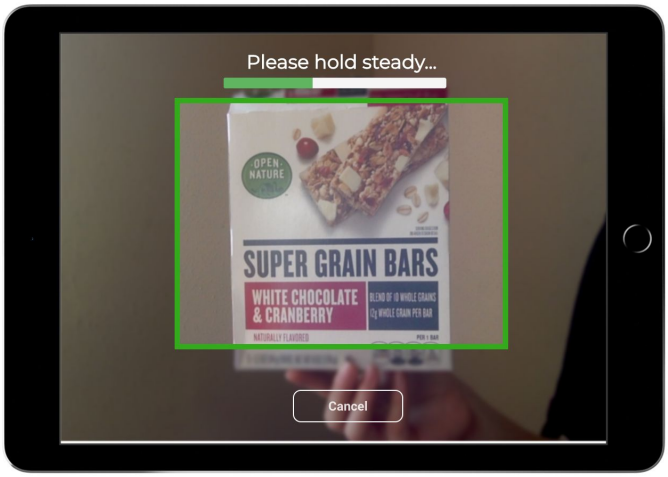
The overall compost, recycling and trash bin with the screen and scanner above.



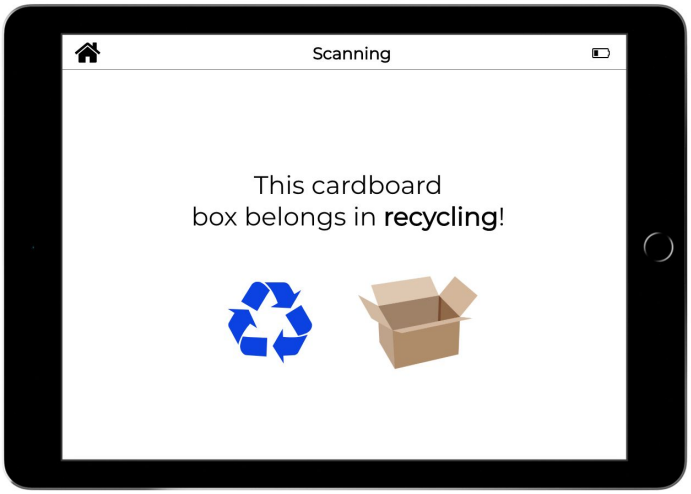
The main screen clearly presents buttons representing the tracking and sorting/scanning tasks.

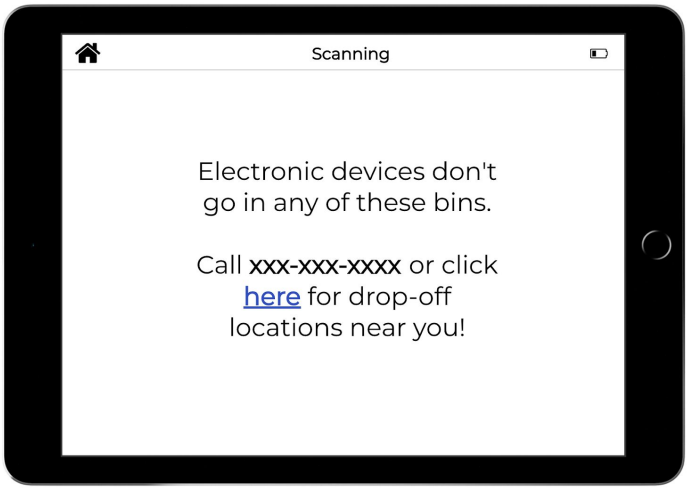
Task 1: Sorting



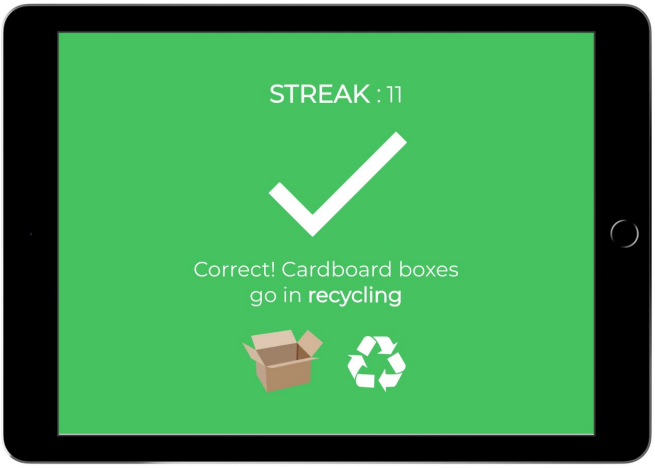


The square was added as a visual aid to help users scan more efficiently/quickly. It also gave them more visibility into the current state of the system.

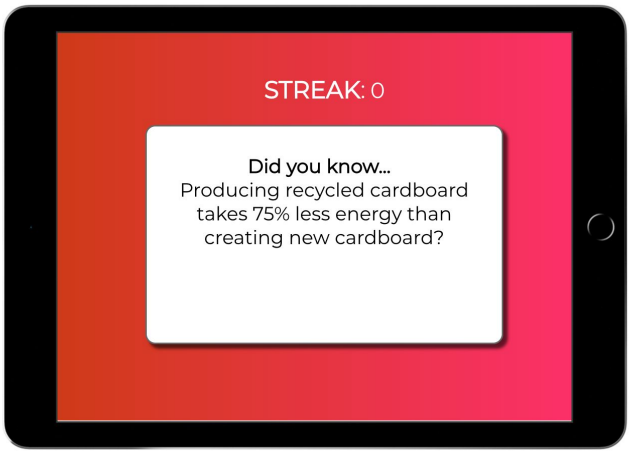




WastePlacer then informs the user of which category to dispose of the item. A minor change is that there are now messages for items that don't belong in any of the bins, such as hazardous waste items, as well as information on how to dispose of them.

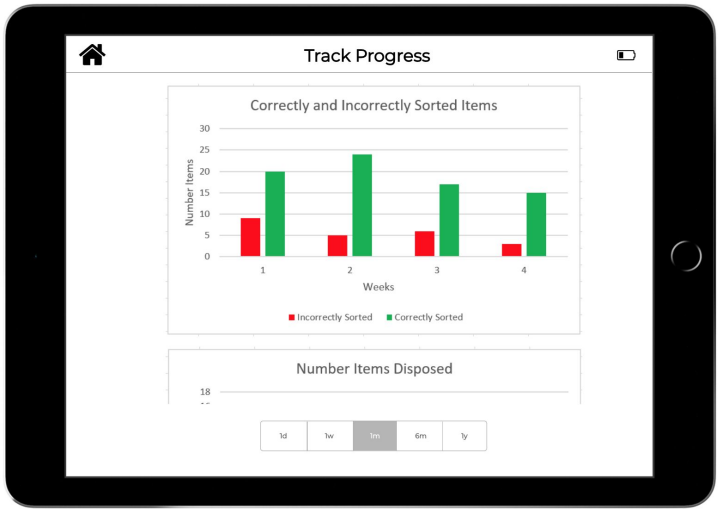


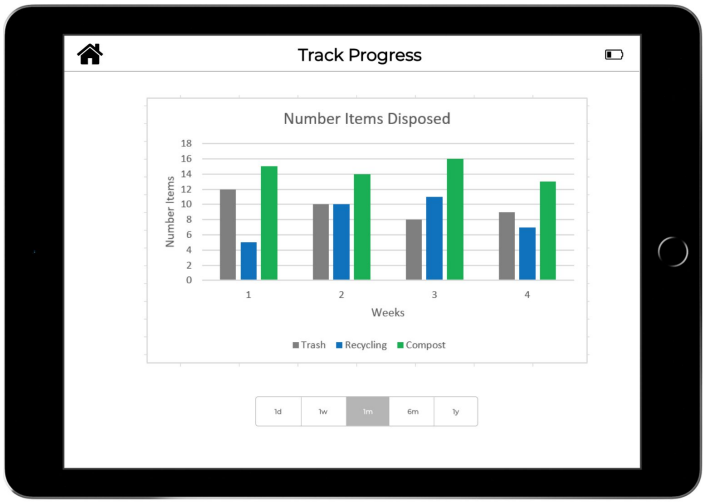
Depending on how the user disposes of the item, a correct or incorrect screen will be displayed. If correctly disposed, the streak will be incremented; otherwise the streak will be zeroed out



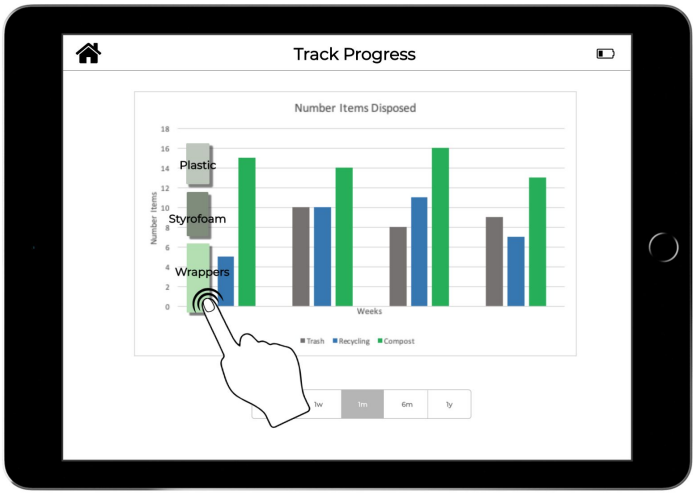
One of the main changes we made is small but important - after the messages of accuracy, there will also be a tip/fact given. If disposed of incorrectly, the fact will aim to encourage users to sort correctly next time. Otherwise, the tip/fact will aim to improve the user's habits further - since they are already sorting correctly, the next step is to reduce, which can be seen in the case of the water bottles. The suggestions will sometimes include links/photos/videos in order to make info more accessible to the user.

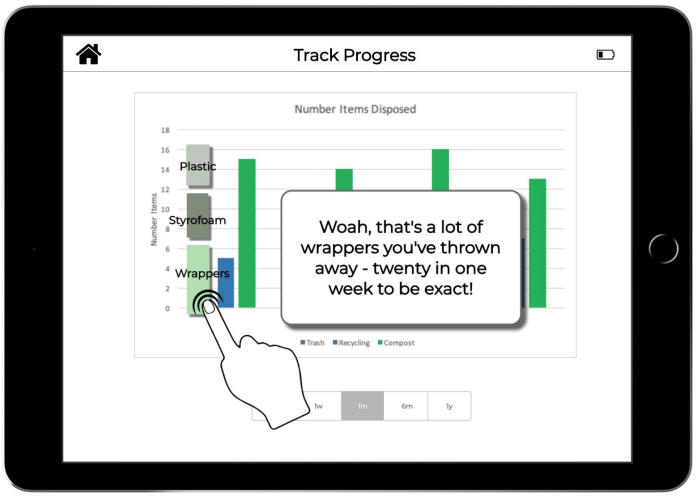
Task 2: Tracking



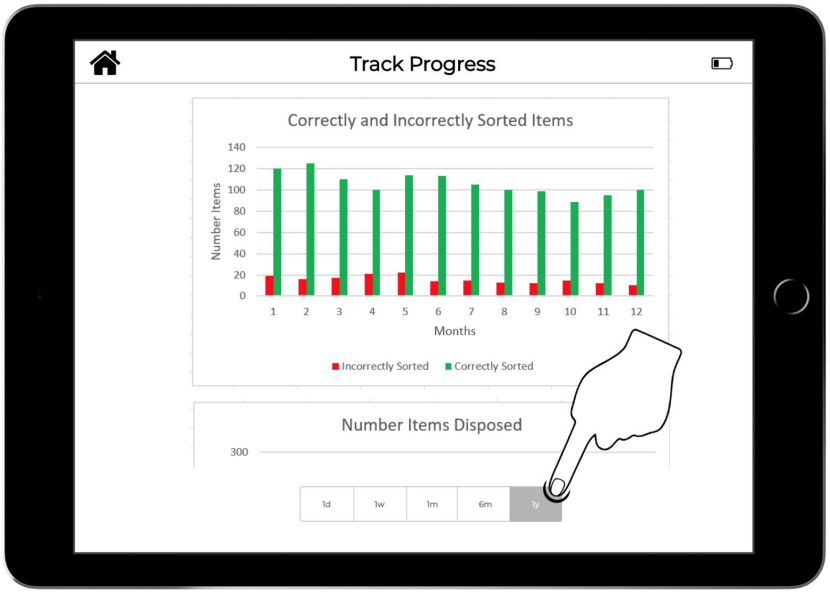


We decided to cut down the number of graphs to the two most important ones: number of items disposed for each category and the ratio of correctly vs. incorrectly sorted items. They can be viewed based on different time frames using the slider on the bottom of the screen.

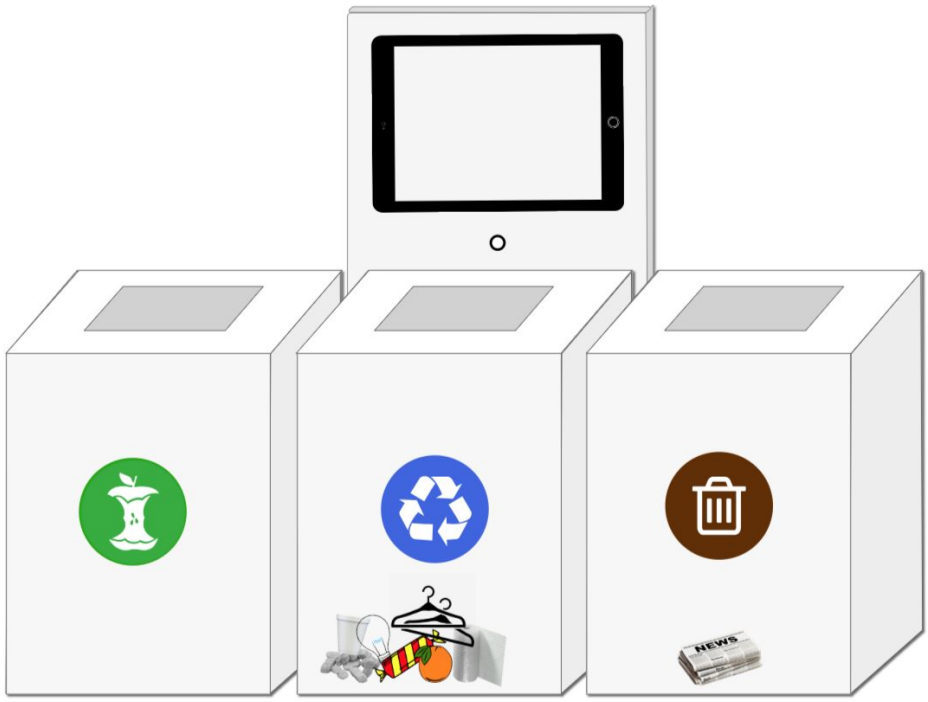




Another aspect we added is the highlighting of problem areas. If a particularly noteworthy number exists such as a high trash number (bad) or very low trash number (good!), the bar will shake in order to get the user's attention, similar to how icons on the mac desktop shake when there is a notification. Once the user clicks on it, a more detailed breakdown of the categories appear and a message pops up. The message may not necessarily explicitly suggest anything, but hopefully increases the user's awareness of their own habits.



The slider at the bottom allows the user to control what time frame they see the graphs in.



This new attribute we added intends to allows users to track incorrectly disposed items. The items appear as images on the bin screens; this provides the user with an opportunity to remove the item and put it in the proper bin. It also acts as motivation factor. The fewer incorrectly sorted items, the cleaner the bin screens look. For example, the recycling bin has many items in it that don't belong and as a result its screen looks cluttered. On the other hand, the compost bin does not have any foreign objects and looks very clean and minimalistic. Once the item is removed, the image also disappears from the bin screen.

Discussion

Throughout the process of making our design, we learned that our design might end up drastically different than how we initially imagined it. This is because it takes many iterations to turn our design into something our participant would actually interact with.

During the contextual inquiry we learned that participants valued efficiency when throwing things away. They also generally thought of their habits as good or average, and that they defaulted to trash when they didn't know where to throw something. From these insights, we made sure to address three important aspects: speed, sorting and tracking. Tracking was especially important because we wanted to emphasize the participants' aggregated impact over days, months, and a year was so that they could see the big picture of their habits.

The process shaped how speed and efficiency manifested in our final design. In our 1x2 design, we initially had participants take photos of their trash/recycling/compost and the design would sort each one and tell them where to put it. However, we received feedback that it would take too long to take photos. So, for the paper prototype, we changed our design to a scanner on the bin, which would theoretically be faster than using a phone to take photos. During the heuristic evaluation and usability testing, we did not receive feedback that indicated inefficiency.

The task of sorting changed as well. Before the paper prototype, we had considered a design that would automatically sort the items. However, we found that this was not satisfactory because we wanted the participant to learn where each item should go. Therefore, we decided to have the participant scan each item if they didn't know where the item should go, and a screen would pop up clearly showing where to put it; after that, they would receive confirmation of if they chose the correct bin. Usability testing affected this because it streamlined our scanning process. We got feedback that the scanner placement was confusing, so we changed it into a camera and had a square boundary displayed on the screen for them. We also clearly labeled our bins with the category due to participant confusion during usability testing.

The task of tracking changed from being a game to graphs and streaks. In our 1x2 design, we had participants compare the amount of waste produced in each category to their friends'. Then we received feedback that the gamification would encourage people to throw more things away. So for the paper prototype we changed the tracking to be streaks for correctly/incorrectly sorted items instead, emphasizing that we don't want people to break the streak. We also displayed the number of items thrown away in each category, as well as the number incorrectly/correctly sorted, in graphs. We removed the "edit" and "delete" buttons for our graphs because we found during usability testing that participants were confused on what these buttons meant. Thus, we removed these functions and only left in the slider for changing the date range of the graphs. Keeping in mind that people would try to keep their interaction with our design as brief as possible, the final result was much cleaner, minimal, and intuitive.

We had quite a few iterations on our design; we switched from smart bins to an app, back to smart bins (our current WastePlacer design) again. We were not expecting to fluctuate so much, but it was necessary due to the iterative process. The number of iterations was appropriate for arriving at our final design.

Appendix

We did not have a written out statement to read to our test participants, but we usually we said something along the lines of the following…

This system seeks to help you sort your waste and help you track it, since most people usually don't know how to dispose of some items and also don't have a really clear understanding of how much they throw away over time. Here are three bins and a screen that will help walk you through the process. So let's say you have a water bottle that you want to throw away into this bin system.

We did not identify any critical incidents, but there were numerous small incidents for our usability tests that are displayed in this usability table.

Incident	**Positive/Negative**	**Severity**
There should be a cancel button included in the scanning screen	Negative	1 (Easy Fix)
More space on the home screen (less clutter)	Negative	1 (Easy Fix)
Bigger and more obvious scanner	Negative	2 (Fairly easy fix)
Show symbol of proper receptacle after scanning instead of words	Negative	1 (Easy Fix)
Edit button for graphs isn't intuitive with sliding	Negative	1 (Easy fix)
Celebrate more milestones	Negative	1 (Easy fix)

Contribution statement

Alex: 20% wrote up the user testing section
Matt: 30% wrote up basically all the other sections
Christine: 25% wrote the discussion section
Anne: 25% wrote the digital mockup, appendix, added more digital mockup stuff