



## Roles

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## Overview of Problem and Solution

Many consumers are in the dark about their home energy usage. Other than monthly utility bills, there isn't an easy way for homeowners to monitor their usage and see where or how they could save money, and as a result, most people only have a broad sense of what their home energy usage is like. They can see from a high level how their usage varies over time, but many lack access to the specific information needed to not only show them how they can save money, but also motivate them to actually follow through with it.

We at JuiceBox intend to develop an application that monitors, tracks, and displays a user's home energy usage, so that users can not only see more specifically how they currently use energy, but also see how they can reduce their energy bills through purchasing more energy efficient appliances and by changing specific lifestyle behaviors. By providing users with more information about their home energy usage, we hope to both help users reduce their energy bills as well as help our society as a whole collectively reduce our environmental footprint.

## Paper Prototype Description

We conducted usability tests to evaluate our proposed interaction design so that we can get direct input on how real users use the design. Paper prototype pieces used in the tests only include the necessary interfaces for the users to interact with major functions of JuiceBox. The prototype is used with Wizard of Oz method as a basis; usability test users would interact with the prototype "believed" to be autonomous, but which is actually being operated by a person.

Four functions from the main menu are visualized: 'Appliance Usage', 'Overall Trend', 'SmartShop', and 'Settings.' The main menu is displayed as a slide-out-from-left sidebar when users press on menu button or swipe left from right; users can do so on every screen of the JuiceBox application to allow easy access.

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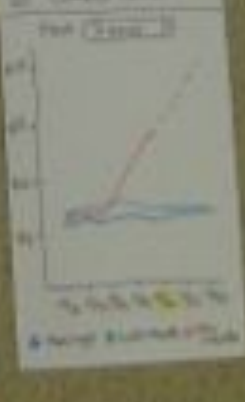
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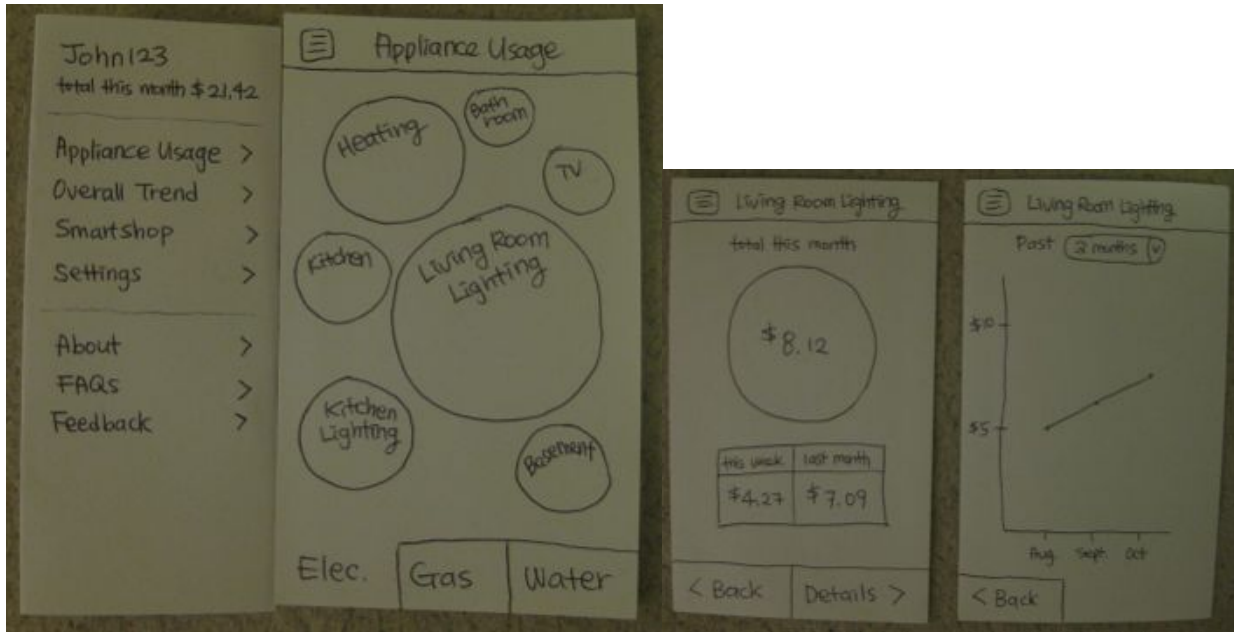
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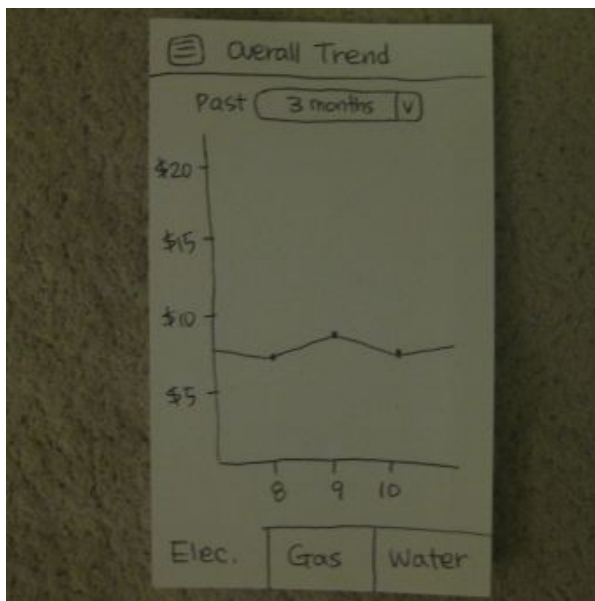
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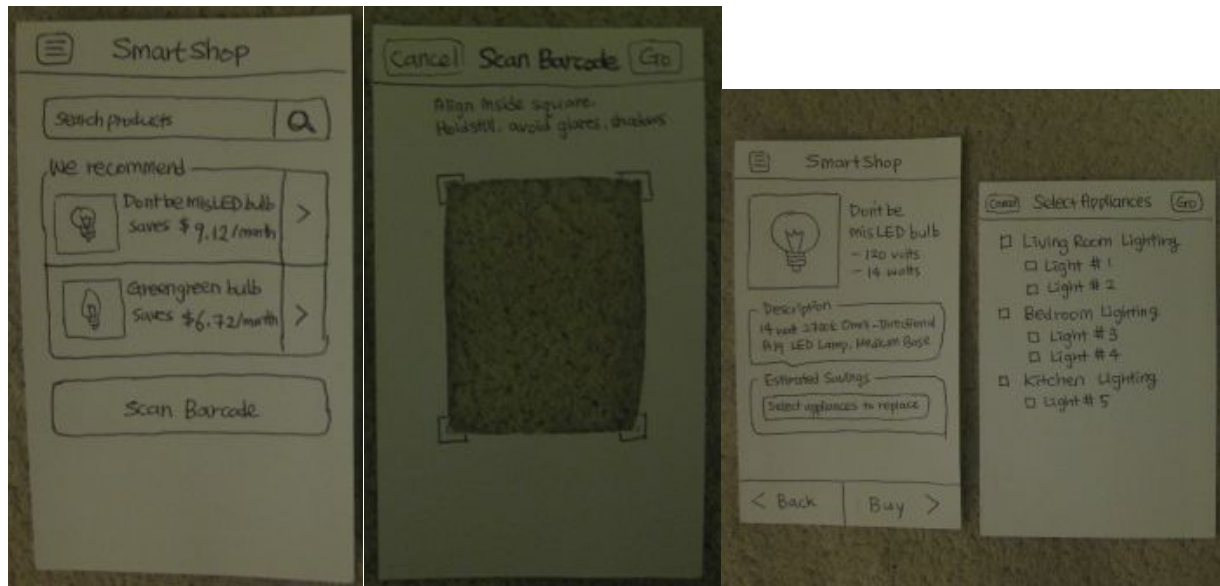


The 'Appliance Usage' screen is the landing screen that users first encounter when JuiceBox application is opened. On this screen, users can see breakdowns of how each type of home energy is used, visualized as bubbles. Each bubble represents a category of appliances, assumed to be set beforehand by the user, and the size relates to how much money the appliance category uses. Tapping on the tabs at the bottom would show the corresponding home energy type's usage breakdown by appliance. Tapping on each bubble brings up a new screen presenting the appliance category's total usage this month, this week, last month. This screen also contains 'Back' button for going back and 'Details' button for another screen.

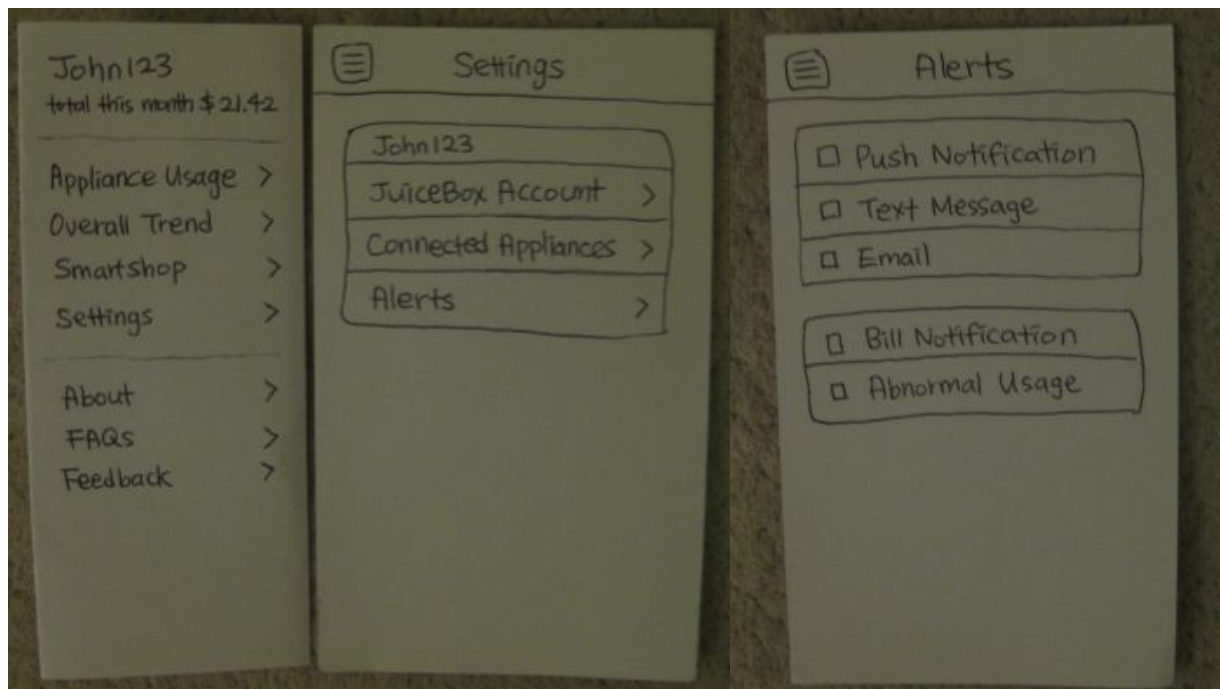
The 'Details' screen displays the appliance category's usage over time, using line graphs in periods of the past 7 days, 3 months, 12 months, and 3 years. Users can choose from these time periods by interacting with a dropdown list above the line graph.



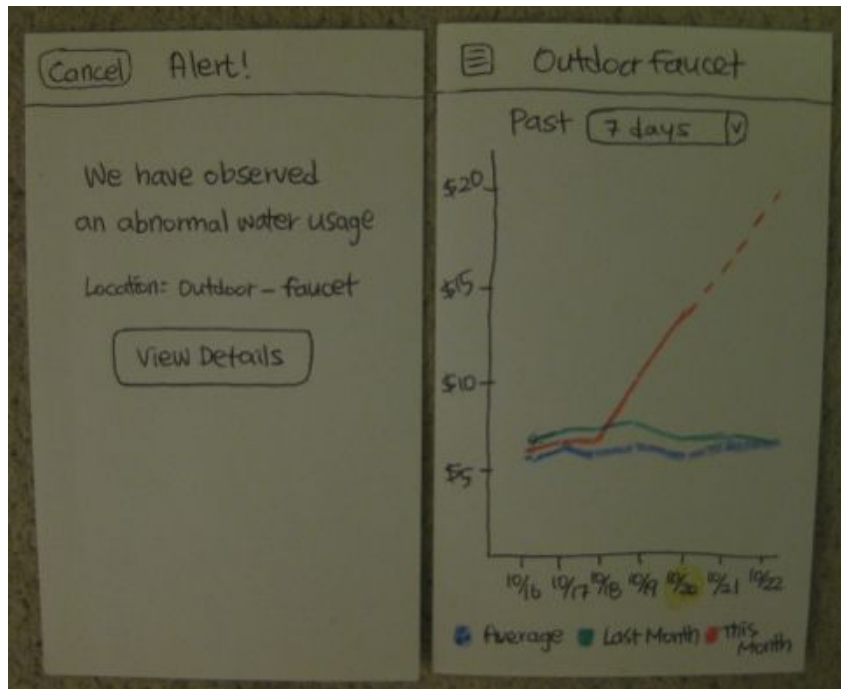
The 'Overall Trend' screen shows a line graph of the total usage of each energy type, with the consistent time period dropdown-list. The energy type tabs are also used here.



The 'SmartShop' screen includes functions of search, recommendation, and barcode scanning. Search or Scan result would include description and a function for estimating savings on purchase, which requires users to click on a 'select appliances to replace' button to bring up a screen where users can specify replacing appliances by tapping of checkboxes and tapping 'go' button.



The 'Settings' screen covers account settings, appliance settings and alerts settings. Alerts settings screen shows two separate sections, each containing checkboxes to select options. Users can choose from three alert method options and two alert type options.



Our paper prototype also includes an example of abnormal usage alert, shown as a screen on the JuiceBox application after the user receiving an alert. The message has a 'Cancel' button to ignore alert and go to the landing screen, a brief summary of the abnormal usage, and a 'View Details' button for more information. The 'View Details' button leads to a line graph screen showing the energy usage over time, with three different lines of different colors. The legend of the line graph is placed at the bottom, showing the color codes of each line. Today's date is highlighted and the projected usage is visualized as a dashed line.

## Testing Method

### Participants

Our first participant was an undergraduate student in UW's Electrical Engineering department. Our second participant was a grad student in UW's Aerospace & Astronomical Engineering and Computer Science departments. Our third participant was a grad student in UW's iSchool. All three live in apartments or houses where they are expected to pay utilities.

### Environment

We conducted all of our tests in the Paul G. Allen Center for Computer Science. Since it was the Sunday before Veterans' Day, it was almost completely empty. This meant that we had a very quiet environment but did not have to watch our noise level like we would in a library.

### Tasks

Included here are the paraphrased task descriptions given to participants.

#### Task 1

“You have just received your electricity bill. It’s pretty high, and you start wondering where all that money is actually going to. You decide to use JuiceBox to figure out what appliance used the most electricity in the past month, and how much money it cost you.”

### Task 2

“You’re on the phone with your mom, and she reminds you of that time you left the oven on for a week. She tells you she’s read that JuiceBox can help you with incidents like these, but she doesn’t know exactly how. Figure out how to get JuiceBox to automatically notify you of incidents like these.”

Additionally, after the third task was complete, we “sent” an alert notification to the prototype our users were interacting with, giving them a chance to experience the alert interface.

### Task 3

“Since your living room lights are using up so much money [as they found out in Task 1], you decide to replace all of the bulbs in your living room. You head to the hardware store and manage to whittle down all the options to two brands, but you aren’t sure which one will actually be cheaper in the long run. Use JuiceBox to figure out which bulbs you should buy.”

For this task, we also gave the users two barcodes they could “scan” with the prototype, one for each “brand”.

### Procedure

At the start of each of the tests, we made sure to inform each user that the information we collect will only be shared with the instructors of CSE 440, that we were testing the interface and not them, and that they were free to stop at any time for any reason. We then briefly showed them how to interact with the paper prototype, and asked them to vocalize their thoughts as they went through the tasks and let us know whenever they believed they were done with each one.

While running the test itself, Daphna was the facilitator, Leah was the “computer”, and Chris was in charge of taking notes. Daphna told them the task descriptions listed above one at a time, and then we observed their actions and listened to their opinions as they tried to complete the task. When a user indicated they were done with a task, they were given the next one.

The one exception to this was that after a user finished the third task, we introduced the second half of the alert system (receiving a notification). We did not tell the users what to do at this stage, but observed what they did until they informed us that they were done.

### Test Measures

We focused on process data rather than any numerical measurements or statistics. The areas we paid most attention to were how long it took users to figure out what part of the app was applicable to each task, and how well the data and interface interaction they faced matched what they expected. We also watched how the users physically interacted with the prototype in case anything was hard to see or click.

## Prototype Testing Results

Testing revealed a number of surprising problems with our interface and a few that we expected. The most surprising issue we found was that one of our three participants did not associate the size of the bubbles on the main screen with relative utility use. He clicked through every bubble looking at the numbers there to compare them because he didn't realize that the bubbles screen showed him a visual comparison. The other two participants, however, immediately recognized that the varied bubble sizes were significant and assumed they corresponded to utility use or cost. It came as a shock that anyone would fail to recognize the feature, however, which made us think about whether we has become too invested in the bubbles and were blinded to its obscurity.

Another surprise was the level of detail participants wanted from the app. They wanted full control over graph scales, for example. Two of the participants said they wanted hour-by-hour data to better diagnose high bills. One participants also saw the "last week" section on the appliance view page and expected to be able to see week-by-week data when he clicked details at the bottom. After seeing that the app could give him data with a week resolution, he knew that resolved data was available and wanted to see all of it.

Users also had preconceptions we failed to think about. For example, users wanted a save button on the alerts page. They wanted feedback to know that the system had seen and would act on their changes. Additionally, users expected the barcode scanner to automatically switch to results when a barcode was detected instead of having to push a button. Beyond expecting not to have to press a button, we found a critical usability issue which was that users simply couldn't press the "go" button while trying to keep their phone aligned with a barcode. One user had to press the button with his nose.

Less surprising interface issues also emerged; things we expected to go wrong did. We had a stub of a product recommendation feature included in SmartShop and it confused all three participants. They generally missed the other two more significant options on the page because they were too distracted looking at the two recommended products. Instead of scanning the products in their hands, two of the participants clicked on the recommended products. The feature was thrown in so this problem came as no surprise.

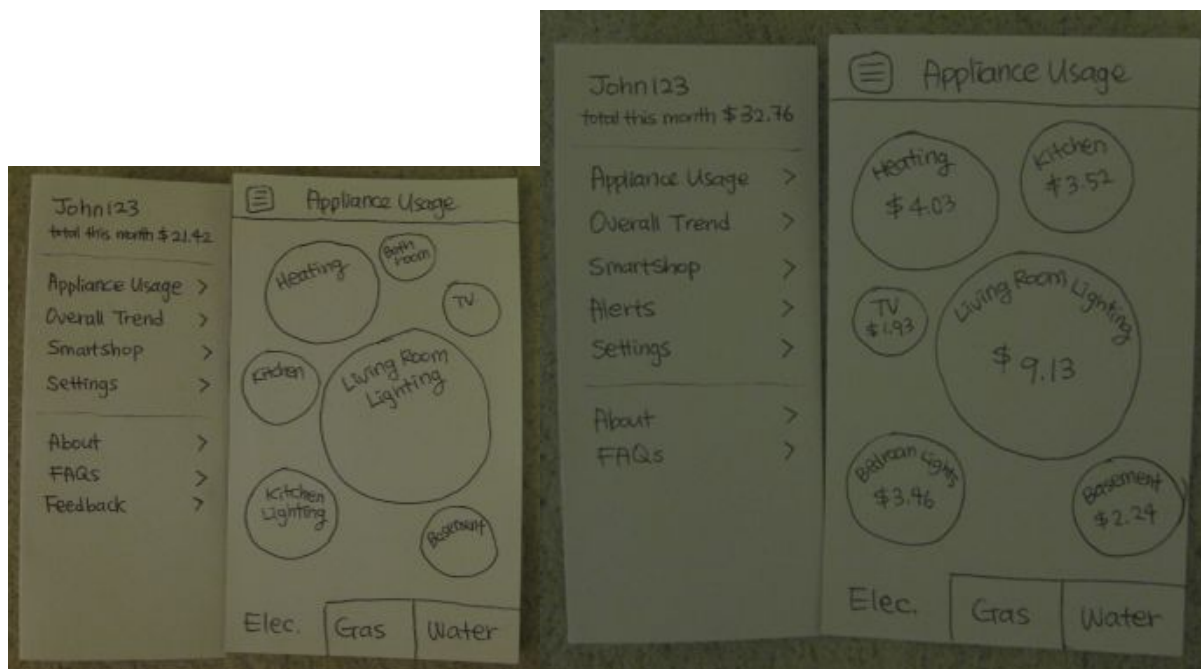
Equally unsurprising was our participants' musings on whether alerts should be categorized as a setting. While designing the interface we had a lengthy discussion on the topic. Our first two participants immediately assumed alerts would be under the settings option in the main menu, but the second commented as he clicked on settings that he expected to find it there but that he didn't think of it as a setting. The third participant clicked on every other option in the menu before resorting to settings. Upon discovering settings he seemed confident that's where it would be, but it took him far too long to check that part of our interface.

The final predictable issue was with our alerts page. We drew it up without a whole lot of thought and overlooked that users might want to set delivery options separately for our two kinds of alerts; two of our users expressed this desire. Our final user also noted that utility bills are usually paid automatically and there are many other reminder services available for that kind of alert. He expressed that the only useful alert would be the abnormal utility usage alert.

We were pleased that users instinctively knew to click on the bubbles to look at details for that appliance. When we designed the bubbles screen we wondered if people would assume interactivity, and during testing all three did without hesitation. All three users also knew SmartShop was the place to

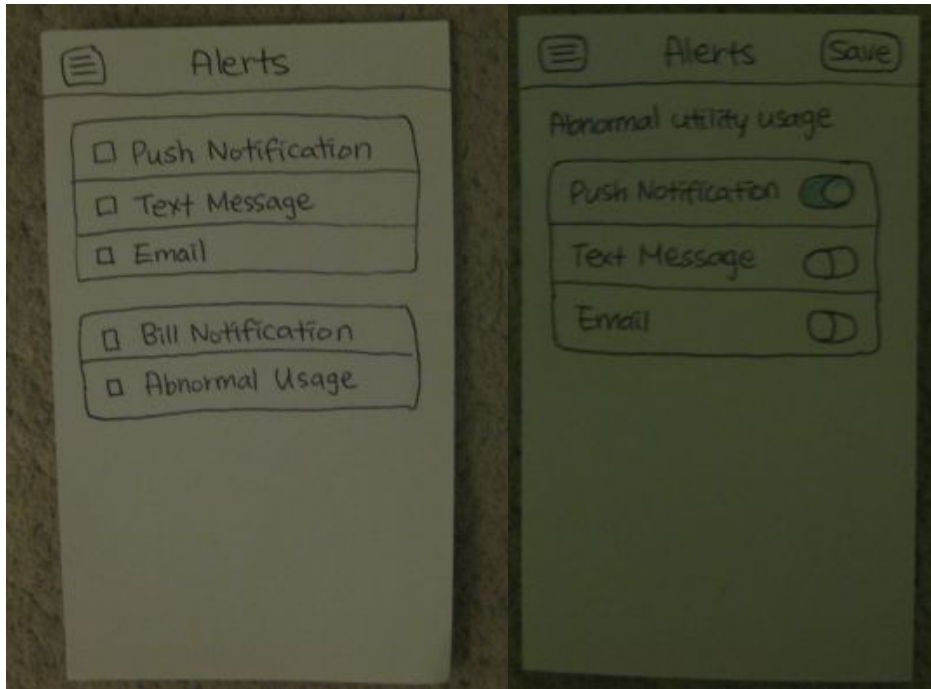
go when presented with our in-store purchase assistance task. In general users seemed comfortable navigating around the interface. No one hesitated to find the menu button, use back buttons, click on the details button on the alert, or click on bubbles as mentioned earlier. A surprising result was that people knew very quickly to select the “select appliances to replace” button after scanning a product. With so much information on the screen we expected them to get lost trying other buttons and reading other details, but each tester read through the information and then clicked the button quickly after reading its label. Users also understood the category hierarchy of the subsequent selection screen; each one clicked on the category checkbox and vocally expressed that they expected the tabbed-over options underneath to all get checked and were waiting for the system response to confirm their assumption.

## Interface Revision Sketches

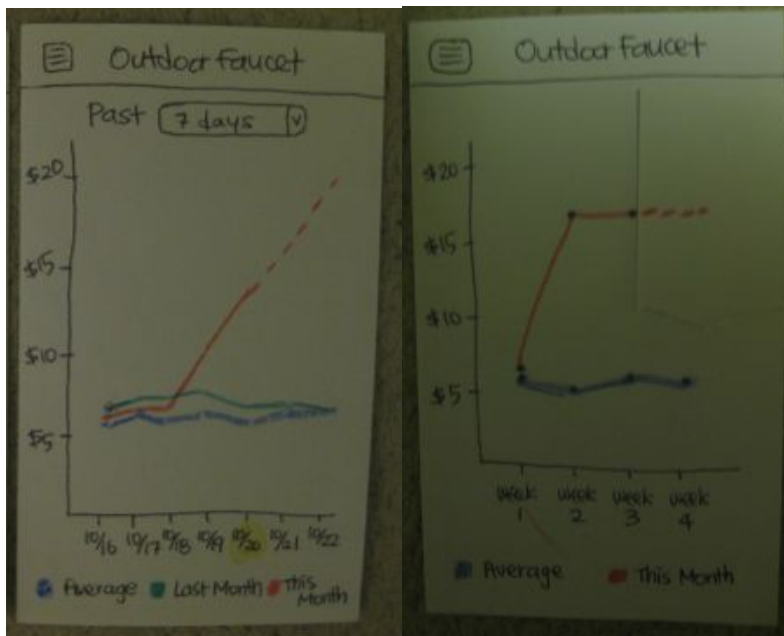


We added a dollar amount to bubbles on the Appliance Overview page. One of the users did not realize that the size of the bubbles was related to how much money the appliance uses, and this addition will make it much clearer as users will be able to see that larger bubbles have larger amounts.





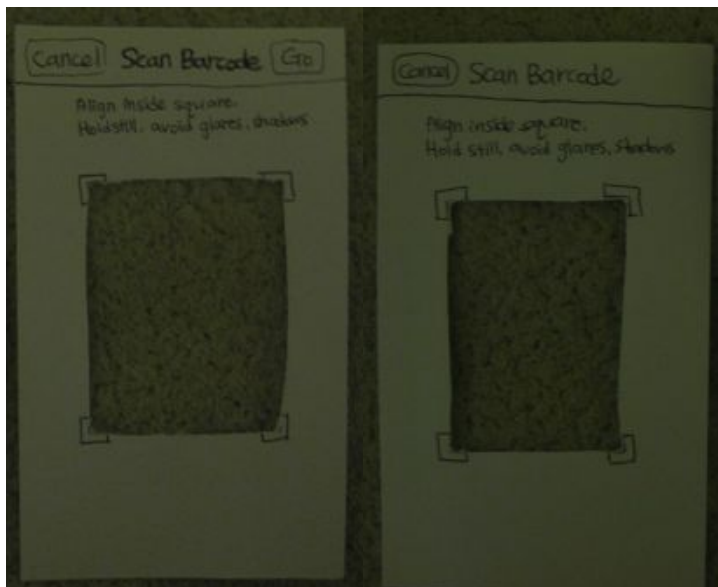
We made a few changes to the alert part of the app. We added a 'Save' button to the screen where users configure their notification settings, because with the previous design, users were not sure that their choices were actually saved. We also removed the option to receive bill notifications, since our users indicated they didn't think the option was relevant or helpful.



On the graph that is displayed when a user gets alerted, we adjusted the time frame displayed. This is in order to help users better interpret the graphs, since a common theme was that they were confused by the information the old graph presented. We also changed the y-axis to be non-cumulative to better match the format of the other graphs.



We made a couple of changes to SmartShop. We removed the recommendations from the Smartshop homepage, because it seemed to confuse users rather than help them.



We also removed the Go button from the screen where users scan barcodes, and instead automatically take them to the product details page as soon as a barcode is detected by the app. Our users indicated that the new design is how they expect barcode scanners to work, and we want our interface to closely match users' conceptual models whenever possible.

## Summary and Lessons Learned

Having never performed user testing before, we were surprised by certain aspects of the process. The end results especially surprised us; we labored for hours over our first prototype thinking of how to make every screen perfect and after testing we find that there are problems we missed. In

fact, there are problems we never would have recognized regardless of how long we spent on it, like recognizing the bubbles' sizes as measurements of utility usage. It appears we were blinded by the development process; we were unable to view our interface from the perspective of a genuine user.

User testing also made us think about higher-level app design decisions. Testing the interface design unexpectedly prompted comments or implications from users about how they would use the functionality of the app as a whole. One user stated off-hand that he would definitely use the app if it was available to him, another pointed out that he would never use the product recommendation feature unless the app specifically told him replacing a certain set of light bulbs with specific new ones would save him a lot of money. These are not comments on the interface, these are comments on the overall functionality of the application from the perspective of people imagining using it. While not the primary purpose of user testing, we still took those comments into consideration in case we wanted to make functionality changes later on.

We also noticed some shortcomings with the user testing process. Testing the interface lacks the context that was so helpful during contextual inquiries. Users aren't in the environment they would actually use the interface in because of the impracticality of performing the tests in the "wild". Our app interfaces directly with the real world, it's relevant to actual events happening in the home. We tried to ask questions like, "if you got this alert sitting on your couch at home, would you click on the details button or get up and look at the indicated appliance in your home?" but users would then have to guess instead of actually being in the situation. Even if they were in the correct environment, users would know they were being observed and have a preconception that the interface would have flaws, which would change their interaction with it. These limitations prevented us from uncovering a subset of potential interface problems related to how people who are, say, shocked and anxious that their water usage is five times the norm will interact with our application.

## Appendices

### Raw Notes

#### User Test 1:

##### Task 1:

Looks like I've used a lot just this week. What happens if I tap on these? (appliance screen, freezer)

Taps on Details after trying other things

**Why isn't there more data?** You have this week, why don't you have the past few weeks? (Odd data chosen to be displayed)

He's not sure he's done with the task.

**Intuitively knows the bubble size indicates the usage.**

"I guess I'm done with the task maybe?"

##### Task 2:

**Clicks on settings intuitively to get to alerts.**

Looks confused on the alerts screen. "I'm not quite sure..." He's not sure what the task is again.

"What if I want bill notifications to go to email but abnormal usage notifications to be push notifications?"

Alerts screen - "how do I say okay, **I don't see a clear way to save**"

Task 3:

Instinctively clicks on smart shop to buy new bulbs but sounds unsure. "smartshop? \*clicks\*"

Seems a little confused about the smartshop screen, not sure why there are products there.

"Do I press go? Oh I press go. **That's not very intuitive.** Barcode apps should just pick it out"

Confused about the information presented, but clicks the "select appliances to replace button" once he finds it. Seems to know that it's what he wants

Seemed to know immediately that pressing the highest level options would select all the tabbed over options below.

"That's how much I save, but how much do I have to pay for it now? How does that compare to my current lightbulbs? I can't really compare them"

Notices that the second bulb scanned will save him more, recalled the original amount saved.

Task 2 continued (alert received)

Usually push notifications don't look like that.

Presses details after reading through the alert.

Notices that the dotted line is a projection but takes a bit to interpret it. Isn't sure why there are dollars there. "Is that dollars per day, dollars per month?" Label it somehow.

He THINKS the dotted line is the projected usage, but he isn't totally sure.

Goes to overall trend after closing the alert.

That push notification was weird.

Post-test thoughts:

Alert details, took a long time for him to figure out what information was being presented to him.

Present tasks as more concrete goals so they know when they're done.

Remove go button on the barcode scanner.

On the appliance details page Paul saw the "this week" data and expected more data with that granularity to be available on the details screen.

Paul already knew about the bubbles.

User Test 2:

Task 1:

Already on the electricity tab - seems to know that they are tabs intuitively

Looks through all the bubbles - more curious about heating than the actual largest.

"That looks like it's pretty high, I'd like to see it on an hour-by-hour basis", clicks details

Bubbles screen - Pain to click on each of these things to see the numbers. Pie chart better.

Thinks the size of the circles indicates the utility usage but isn't sure - didn't realize this for a long time.

Would click on each bubble individually to try to compare their usage. **Still isn't sure the size of the circles is relevant.**

Color may add information about usage and indicate what the bubbles mean

Task 2 - phrased as "use juicebox to find out if usage is abnormal"

Instinctively clicks on help options to try to figure out how to do task instead of exploring the interface.

"Clicking around aimlessly is not necessarily the fastest way"

Tries first to go to appliance usage, then clicks on an appliance and goes to details.

Doesn't know, because of phrasing, about the concept of an "alert".

Goes to smartshop and overall trends before going to settings, just so see what's there.

"Settings may also have some kind of alerts, that may be a good thing to check out"

Alerts immediately after settings

Abnormal usage is the obvious one

"I guess these are all checkboxes"

He would have just exited without selecting an alert delivery option, need way to **warn the user that they have not selected a delivery option.**

Task 3:

Uses smartshop instinctively, although he already found this option earlier

Recommended appear to be the ones im considering (prototype issue, not design issue necessarily), seems confused as to why they are there and what their being on the screen means  
Barcode scanning apps need a line in the middle.

**I can't hit the go button as I'm holding this.** Uses nose to press the button.

Barcode apps should be automatic

Select appliances to replace, takes a while to see the button but clicks on it quickly after noticing it.

Knows that clicking the category will select all options underneath.

"12.79 a month sounds good" hits back

He expected it to go back to the barcode scanner, not the smartshot main screen, when hitting back after scanning.

Selects appliances to replace again, doesn't comment about whether the previous options should still be selected or not.

Second ones appears to be better, remembers and compares in memory.

Presses on the recommendation options out of curiosity. Sees the buy button and presses on it out of curiosity.

Task 2 continued (alert received)

Selects view details after reading through entire alert

He seems confused about what the details mean. "The graph is a little bit confusing".

Not sure what average means, makes a correct assumption but isn't sure.

Looking for peaks and valleys.

Knows that the dotted line is projected.

Wishes he was told about the abnormal usage earlier, it's always many standard deviations away.

Would immediately check the faucet, then check the surroundings for signs of being on recently.

Would then test the hardware collecting the data, and go to feedback if he thinks it's not working properly.

Additional comments:

Looks at settings again.

In account settings would expect to see user name, password change, connect to online utilities account (pse, etc). Expects some way to connect to utilities company info.

Curious about how to categorize appliances, the process seems relevant to him.

Post-test thoughts:

Didn't know how to interpret the bubbles.

Must use the word "alert" when describing the second task, Nat didn't know that the app would do it for him.

User Test 3:

Task 1:

Seems to associate size of circles to amount of energy used. Surprised that living room is higher than heating. Using the data as expected.

Clicks on a bubble expecting something to happen.

Cares about -why- the bill is high, not necessarily exactly how high it is.

Looks at weekly cost and compares it to monthly cost -"half of my month's bill so far was last week?"

Wants to see energy use by time of day - clicks on details.

Taps on "3 months" dropdown. **Wants hour-by-hour information.** Wants to see daily hour-by-hour trends (describes them as sin waves)

Task 2:

Hits back twice instead of the menu button to get back to the appliance overview screen. He views it as the "main" screen that everything else is accessible from.

"Feels like a setting or something"

Goes to menu button - feels that it's more likely to be there than on the appliance overview screen.

Knows that appliance usage on the menu is where he just was.

Clicks on settings, but says it's not quite how he would think about it.

Seems a little **confused by the alerts screen.** "These are all checkboxes? I want push notifications for this, and emails for that"

Wants three delivery options per notification, not separately. Tedious, but fine-grained control. Not how he's used to thinking about it.

Task 3:

Looks and analyzes what's written on the bulb first, before using the app.

Would have to have known ahead of time that JuiceBox could help with this, wouldn't normally associate in-store purchases with an app.

Smartshop sounds like the most likely thing.

Relies heavily on looking at the bulbs' packaging for information.

Looking at the SmartShop screen, doesn't notice the scan barcode button. Tries to compare to the recommended items

Reads through all of the provided information after scanning bulb, before looking for selection options.

Selects the "select appliances" button upon seeing it, no hesitation.

Knows that selecting the left-justified options will select all below.

Selects "Go" without much hesitation. Small "Um"

"Now I need to know how much I would save with these, **I have no idea what I'm using right now**" (current energy usage)

"That's saving a lot more" second bulb scanned. Remembers last scan and compares mentally.  
No price listed after scanning.  
Hits buy expecting price comparisons between different stores and online.

Task 2 continued (alert received)

"We? Who?" (on alert message)

Sees alert and situationalizes it "If it was december... pipe maybe burst... But it's October..."

Clicks view details, thinks he'll get information faster than just guessing.

Knows that costs going "up and to the right" are bad. Doesn't seem to assume accumulation, which was a worry discussed before this test.

Doesn't recognize dotted line as a projection.

Sequential months are irrelevant to compare, "just sort of a strange comparison" conditions may be dramatically different "could still be watering plants"

Not sure what the vertical axis units are. "per day?"

What he really cares about is knowing exactly when that thing (the cause of the alert) happened.

"There's nothing that explains where it started taking off here"

He would just go look. "Something's probably going on, or the sensor is just confused"

Maybe the hardware is broken.

Lots of different possible causes, would investigate after viewing details on the alert.

Upon seeing the alert, most important thing is to go see the appliance noted, but would click on details on the way.

Additional comments:

SmartShop - would rather tell the app which appliances I'm replacing and get recommendations.

Had to tell the app twice which lights I was replacing

Want to pinch-to-zoom and drag to navigate around graphs.

Thinks the app as a whole would be very useful. Currently data is not very fine-grained, a lot of stuff happens in a month, need much more detailed timeline to know what happened.

Would like to know very quickly whether something will save me money.

Predicting savings is very relevant and interesting.

Doesn't think of alerts as a setting.

Doesn't know I he should have to remember to turn on alerts. If you have high confidence that something is amiss, just tell me, I shouldn't have to enable that.

Doesn't think billing reminders are relevant, would manage that in other ways.

Interested in changes over time in general, not relative costs of different appliances.

**Show trends (up arrow, down arrow) on the bubbles.** Graphs gives much more information.

SmartShop feels like a totally different use case. Understanding usage vs shopping. He wouldn't remember that this app also does shopping.

Scanning barcodes is tedious, wants automatic advice not a tedious tool.

Wants an option less intrusive than a push notification.

Loves the idea of the app in general. Purchased a Nest, conscious of utility usage.