DESIGNING DIGITAL SERVICES FOR GLEANING IN ATLANTA

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ABSTRACT

This is the compiled work for my master's project, advised by Dr. Carl DiSalvo, as a requirement for completing the M.S. Human-Computer Interaction degree at Georgia Tech. First, I present formative work that describes gleaning as a practice to reduce food waste and improve food security, and my fieldwork using mixed research methods with local practitioners and leaders in this space. This is followed by my systems-oriented design iterations and prototyping of Gleanhub, including research through design (RtD) methods in open source civic communities. Finally, I present an evaluation of Gleanhub and the system, discuss further work, and suggest future work including immediately actionable projects.

FORMATIVE WORK

SUMMARY

Gleaning is the practice of salvaging food left over from its intended use. In this paper we present research into the activities of gleaning with an emphasis on the tools used in gleaning. From this research we identify a series of design opportunities. Perhaps the most fertile opportunities are related to socio-technical networking: the processes and infrastructures for providing information about the availability of food for gleaning and access to the actors who can move and store gleaned food.

INTRODUCTION

In 2013, an estimated 14.3% of Americans had inadequate access to food sufficient for an active and healthy life (Coleman-Jensen et al., 2014). Yet 31% of the food supply at the retail and consumer levels went uneaten (Buzby et al., 2014). This imbalance suggests inefficiencies in how the country's food systems are managed on an institutional level. On an organizational level, food banks and similar entities are effective at reducing food insecurity by diverting some of the safe, edible food that would be wasted by grocers and restaurants to the organizations' food-insecure clientele. However, these services are limited by their operating capacity. We found that on an individual level, people who pick up already wasted food from dumpsters and bins are limited by their means of

transportation, knowledge of what food is still edible having been thrown away, and the social stigma of dumpster diving. These efforts by both organizations and individuals are known generally as “gleaning,” “food recovery,” “food rescue,” or “food salvage.” This variation in terminology is evidence of a spectrum of perspectives and activities. In this paper, “gleaning” refers to practices of salvaging food left over from its intended use.

Gleaning has long been a common post-harvest activity, where seasonal farm cycles would signal locals to glean leftover crops from the fields. Today over 80% of Americans live in urban areas (U.S. Census Bureau, 2012), away from not just the fields that produce food, but from the grocery stores that distribute it. Over 15 million low-income people in these urban areas live in “food deserts” where access to large grocery stores is limited, and many do not have access to a vehicle (Ver Ploeg et al., 2012). As our food systems take shape in more urban contexts, it becomes more appropriate to consider gleaning as a post-distribution activity.

“Farm children gleaning field after wheat harvest”
William Vandivert, 1941, for LIFE Magazine

Dumpster diving is a modern, urban form of gleaning
Source: mrmondialisation.org

While individuals may glean food for themselves, it is more common for volunteer or non-profit organizations to glean food and then distribute to communities to combat food insecurity (Hoisington et al., 2001). In a critique of this practice, Allen (1999) asserts that food insecurity is not solvable by community-based food systems alone, but rather by community food system actors working together with traditional government programs. She identified actors like community gardens and food banks in the food system and found that when operating within only geographical or political bounds, they were at best individually insufficient and at worst counterproductive by tending to best serve the more privileged.

Gleaning often occurs at large, community-size scales, with organizations like those interviewed in this survey and government programs providing for food security.

Gleaning also occurs on strictly personal levels (Hoisington et al., 2001), such as bakers taking home unsalable pastries, dumpster diving behind a grocery store, and individuals living a freegan lifestyle based on sharing resources (Pentina & Amos, 2011). So while an individual may relieve one's own food insecurity via these practices, it may not scale and solve insecurity on a community level, as Allen suggests. However, when these people's individual interests are focused on activities related to shared problems like food insecurity, their practices can be analyzed as citizen politics—a conceptual framework for improving the effectiveness of public stakeholders in doing public work. By analyzing activities in this way, design opportunities can be more easily defined by common modes of public problem solving, including their strengths and limitations (Wagner, 1996). McCullum et al. found in one case that citizen politics was an effective framework for diverse community members to both find common ground on food security topics and build an agenda only when changes would not conflict with more powerful stakeholders (2002; 2003). When powerful government-affiliated stakeholders antagonize gleaning and community food security efforts, however, there is a challenge to Allen's argument of community food security supplementing, rather than replacing, traditional government programs and policies. For example, Orlando, Florida enforces an ordinance that blocks any feeding event "likely to attract" 25 people to a public space without a permit, of which the city only provides two per year (§ 18A.09-2.). Similarly, corporate policy often prevents retailers from giving out unsold food and uses locked trash compactors instead of open dumpsters for disposal, despite national legislation encouraging and protecting donation (104th Congress, 1996).

Among other literature reviewed, there was no research that modeled the complex interactions between actors, policy, and the food itself. Whereas Allen (1999) suggested stronger interaction between community and government actors, McCullum (2001) cast doubt when power differences among the participants were substantial. Without better understanding how these factors interact and conflict, we are left with an inadequate picture of the design space for gleaning, which would seem to be a promising practice for addressing some issues in community food systems. Our research, then, was motivated by a hope to articulate this design.

In this paper we present research into the practices of gleaning, with an emphasis on the tools used in gleaning and how those tools work to structure a socio-technical system of exchange. From this research, we identify and discuss a set of themes and design opportunities.

RELATED WORK

Over the past decade there has been an increased interest in food and food systems within the human-computer interaction design community. The approaches to food and food systems are diverse, expressing the pluralism of the HCI community. For some, cooking and eating (and to a lesser extent growing) are seen as opportunities for novel interactive systems and interaction techniques (Comber, et al 2012). More common, however, is the exploration of food and food systems in relation to health and sustainability. Given the increase in obesity and food-related disease, it is not surprising that many researchers in both HCI and various health fields see digital interventions as a promising site for tracking and changing eating behaviors (Andrew et al. 2013, Chang 2014). In many cases, food and food systems research has been framed in relation to sustainability. This work includes both efforts to increase awareness of sustainability issues with regards to food systems (Hirsch, et al 2010, Choi & Blevis 2010), efforts to support more sustainable food consumption (Bohner 2009, Clear 2013), and efforts to support more sustainable practices of growing food [Heitlinger, et. al 2013, Hirsch, et. al, 2010, Lyle, et. al 2015).

Within this corpus on food and food systems, we situate our research in relation to work on food waste (Comber 2013, Ganglbauer, 2013a, 2013a, 2014) and food justice (Grimes, 2008, Dombrowski 2012, 2013). Gleaning is a practice of making use of food waste, or rather, of keeping food from becoming waste through inventive means of recovery and use. To date, most studies of food waste and practices and tactics for recovering food waste have emphasized the domestic sphere and individual or small group dining. (Comber 2013, Dombrowski 2012, Farr Wharton 2014 Ganglbauer, 2014) Our work adds to that by exploring practices, tactics, and opportunities for food waste recovery at two other scales: the scale of the individual gleaner and institutional/organizational gleaning.

In addition, we draw inspiration from work exploring issues of food justice, or the intersection of food and food systems and social justice. (Grimes, 2008, Dombrowski 2012, 2013) As became apparent through our research, so much of the activities of gleaning are rooted in beliefs about sustainable and fair distribution and redistribution of resources. For many, gleaning is a way to work against injustices in the food system and contribute to the food security of a community. As such, emerging research at the intersection of food justice and HCI continues to motivate our work.

METHODOLOGY

We drew upon Ericksen's (2007) framework for studying and evaluating food systems affected by issues of food security and social welfare to structure our investigation and analysis of gleaning practices. This framework helped guide data collection by defining

and categorizing key activities and actors involved in food systems. For example, foraging is not gleaning, because there is no extant human intentionality behind food that could be foraged, whereas gleaning involves taking food that previously had an intended purpose. The framework also informed analysis by understanding the activities and actors individually, as well as how they interact in key processes for the system's outcome. In addition, power imbalances McCullum et al. (2003) reported in setting food security agenda were important when analyzing the relationships between decision makers and among the scope of different policies.

Defining Activities

Ericksen's framework groups food security activities into four categories: production, processing, distributing, and consuming. This concurs with a Natural Resources Defense Council report, which includes an additional category following production: postharvest handling and storage losses. Based on our review of gleaning organizations, we use these same frameworks to inform our own categories of gleaning activities:

- **Field Gleaning**
  Harvesting crops left in the field or on the farm after harvest, often due to market forces and pest damage (Gunders, 2012). Large organizations like the Society of St. Andrews and government initiatives often operate within this category (Hoisington et al., 2001).

- **Small-Scale Transportation**
  Often non-professional drivers of common vehicles like cars, vans, and bikes moving gleaned food between other activities. Volunteers drivers are critical to food pantries and peer-to-peer services like Nourish Now (Derrickson, Spellman, Rice, & Mahoney, 1999; Eisinger, 2002; Tarasuk & Eakin, 2003).

- **Large-Scale Transportation**
  Large networks like Feeding America food banks require a reliable fleet of trucks to transport millions of pounds of food between sources, food banks, and agencies like food pantries.

- **Storage**
  Long-term storage of food, often in bulk, often co-located or closely related to other activities. This includes food banks that manage large-scale gleaned food networks and small food pantries that distribute food to their clientele (Vitiello et al., 2013).

- **Food Pantries**
  Food assistance organizations with facilities for acquiring donated food, especially

from food banks, and distributing directly to individuals and families. This includes church kitchens, community food security organizations, small nonprofits, and homeless shelters (Vitiello et al., 2013).

- **Preparation for Consumption**
  An end point to gleaned food is back on another person's table after distribution by food pantries, dumpster diving, restaurants like wasteED, and stores like Daily Table.

- **Dumpster Diving**
  Obtaining food from dumpsters for consumption is a common practice among homeless people (Eikenberry & Smith, 2005), freegans (Pentina & Amos, 2011), and even food-secure people (Vinegar et al., 2014), This activity reframes places of waste as places of second-hand resources.

- **Relationship Management**
  Among all literature surveyed, networking is by far the most prevalent activity, though not itself a gleaning activity *per se*. However, it is a critical aspect of each category that enables disparate stakeholders and networks of stakeholders to work together. As such, it is important to consider this activity on its own as it relates to HCI.

Fieldwork

With these categories in mind, we sought out experts and prominent individuals involved in the services and organizations with public points of contact. We also identified some people through our own contacts and used our personal connections in addition to their public profiles to invite them to a semi-structured interview. We interviewed multiple people at larger organizations like a local food bank and food pantry, as they specialized in different gleaning categories and provided a more holistic picture of the organization's role in gleaning in the local food system.

Each category's social network in the Atlanta Metro Area was unique, making recruitment somewhat difficult. For example, food preparers could get in trouble for some gleaning practices, dumpster divers were only found by word of mouth, and all farmers surveyed had very little waste or surplus food to be gleaned. Therefore, for the latter, we interviewed a field gleaner from farms rather than farmers themselves. In total, we interviewed eight gleaning experts.

Participants	**Gleaning categories**

Troy Alda, food sourcing specialists at the Atlanta Community Food Bank (ACFB)	Large-scale transportation, Storage, Relationship management
Matthew Swift, food sourcing specialists at the Atlanta Community Food Bank (ACFB)	Large-scale transportation, Storage, Relationship management
Ryan Watson, vice president of community services at the Atlanta Community Food Bank (ACFB)	Relationship management
Richard Aniston, leader of Atlanta Food Not Bombs (AFNB)	Food pantries, Preparation for consumption, Relationship management
Emma Simmons, former food pantry manager at Buckhead Christian Ministry (BCM)	Food pantries, Relationship management
Kim Stone, interim volunteer manager at Buckhead Christian Ministry (BCM)	Small-scale transportation
Al West, a dumpster diver in Atlanta	Dumpster diving
Taylor Bale, program coordinator for south Georgia at Society of St. Andrew (SSA)	Field gleaning, Small-scale transportation, Large-scale transportation, Relationship management

The bulk of the data presented in this paper comes from a series of interviews and follow-up emails on particular questions found from subsequent interviews. Each participant was invited to a semi-structured interview to discuss the gleaning practices of their organization, their own, and others they may be familiar with. In particular, participants were asked what enables and limits their current or planned activities so that this study could expose design opportunities. They were asked to describe the ways they glean, breaking down the individual tasks performed by the participant and their organization as a whole. They were also asked to speculate how they, their organization or community, and Atlanta overall could make them more effective at their gleaning activities and the issues they sought to resolve through these activities.

FINDINGS

In what follows we present a description of the tools used to support gleaning across multiple organizations. Each organization operates at a different scale, with different commitments and practices, which is reflected in the tools they use, and do not use, to facilitate gleaning. Understanding tools uses within and across these organizations provides insight valuable to design by identifying what works and what needs are currently unmet.

Atlanta Community Food Bank

Feeding America was the U.S.'s leading domestic hunger-relief organization that supports a network of food banks like the The Atlanta Community Food Bank (ACFB) (Mills et al., 2014). Each food bank coordinated sourcing and distribution for its locale, improving food security by supplying both processed and fresh food to their agencies

As food sourcing specialists, Troy Alda and Matthew Swift's goal was to maximize the ACFB's food income from donors like farmers, food packers, and grocery stores. These food donations would be transported to the food bank's storage facilities and then to its 600 agencies (including food pantries, soup kitchens, and other verified distributors) in 29 Georgia counties. Alda and Swift's tasks were primarily related to communication and networking, and they indicated their most valuable tools were email and phone, both mobile and landline.

They also used software developed for Feeding America food banks called Choice and Produce Matchmaker. Choice was a web application that applied a market-like economic system to the food bank network and its sources, using food as the only tradeable items and "shares" as a fiat currency. Food sources electronically sent their donations to Feeding America, whose customer service department reviewed, processed, and posted to Choice. Once available there, food sourcers like Alda bid with their shares to win the

items for their food bank. Shares were regularly allotted to food banks based on their needs, but they could also get more by bidding a negative number of shares on items. This often happened when an item may be undesirable or difficult to move, so a food bank charges shares (i.e. offers a negative amount) to take the item.

Choice used to be the system for both packaged goods and fresh produce, but in late 2015 a similar web application called Produce Matchmaker was developed to handle produce exclusively. Unlike Choice, food sources could directly upload their donations to the system, which was then vetted by Feeding America's produce team. Another difference was that Swift said that the share-bidding system on Choice did not work out for produce, so food banks pay with money to transport produce claimed on Produce Matchmaker.

The ACFB website was another important digital tool for attracting visitors and providing information on how people could donate food to the food bank. Aside from ACFB's contacts that he could contact directly, he could also network with contacts like produce distributor Fresh Point's board of directors to seek out more donors. Similarly, organizations like the Georgia Food Industry Association maintained a list of businesses that he could cold-call or ask a mutual contact to introduce him to discuss donations to ACFB. For example, several times a year he would attend large events where there would likely be surplus food, such as the National Association of Convenience Stores' trade shows. In this case, he would give sheets of stickers to attendees who were displaying their produce, asking them to attach the stickers to their unsold produce so ACFB could haul it away after the event.

The sourcing specialists worked closely with transportation and other logistics specialists at ACFB. ACFB relied heavily on their own fleet of trucks to move large amounts of food, usually from distributors (Kraft, ConAgra, Nestle, Kroger, and local warehouses) and retailers (Publix, Walmart, Sam's Club, Kroger, Target, and BJ's). To source food, Alda kept track of donors and potential donors, where food was and would be, and where the fleet drivers were. Without the fleet, donors and agencies would be far less accessible since they often lacked the time and resources to move the food themselves. Although, agencies also handled ACFB's relationships and acted as "enabled" drivers to recover, store, and deliver donations. When ACFB's trucks were unable to move a load of food, it was sometimes cost-effective to hire a commercial trucker. Other times when ACFB trucks weren't immediately available, such as outside of business hours, he helped donors with how to optimize food recovery and storage until the trucks were available. Major distributors also use DonorExpress, also developed by the Choice creator, to make

their donatable food available to Feeding America with less reliance on an individual food sourcer.

Finally, ACFB's warehouse stored all their produce that couldn't be immediately routed to their agencies. Though most of their donations were stored in pallets, they packed assortments of food for distribution to food pantries in Chiquita banana boxes, whose lids folded to leave a small opening in the top. This allowed the agencies to more easily check its contents to sort and distribute the food to their clients. Other food banks, Swift said, use similar second-hand items like milk crates; all of which are shareable on Choice. Since 2010, ACFB has almost doubled their annual donations to 60 million pounds; however, the warehouse's pallet and freezer spaces were meant to store only 40 million pounds. Agencies, too, didn't always have the logistical power for what they ordered. For example, a church operating as a food pantry may have limited kitchen space or van availability to store and move food as it becomes available. Agencies can use another product developed by the Choice creator called AgencyExpress to better handle these issues.

Atlanta Chapter of Food Not Bombs

Food Not Bombs (FNB) was an international organization that recovers food that would be discarded by stores and restaurants and shares it with communities to bolster their food security and to protest war and poverty, according to their website. Their local, often municipal, affiliates operate independently of each other, only having a name and general goals in common. Its website provided general information about what the overall mission and methods were for gleaning, including instructions for starting and contacting FNB groups. Related to the social stigma of certain gleaning activities, the website dispelled misinformation and linked to stories about individuals with the organization and its groups.

In Atlanta's group (AFNB), started by Richard Aniston, members recovered food from their personal contacts in the food industry and warehouses. Every Sunday, they met at their house in the Edgewood neighborhood of Atlanta to cook and prepare the foods to freely distribute in Woodruff Park downtown. Their clients were often homeless or disabled, though passersby also lined up for a plate. Their house was a place to distribute food and supplies throughout the week, including anything that wasn't consumed at the park, and to freeze food for distribution later. The group moved their food, table, cooking equipment, and other items in a van and another member's pickup truck. Without their own vehicles, Aniston said that their work would be extremely difficult to coordinate. While at the park, the other members helped distribute food while Aniston worked to engage people in the area. In this case, Aniston brought drums that attracted a

number of people passing by to join in temporarily and others for hours. This operation in a public park was an example of how FNB groups achieved their general goals of promoting awareness of homelessness and food insecurity.

Garnering attention like this helped build AFNB's personal network of contacts that was critical to enabling AFNB's operations. They tried using digital means, like text messaging and email lists, to find and manage contacts, but it did not help them coordinate both availability and pickup of food at the same time. That coordination was critical to gleaning foods with a small window of availability, such as from restaurants. Aniston suggested that they could have used a digital exchange board, similar to Craigslist's free listings. However, he described Craigslist itself as "very alienating" since users would all be strangers, whereas AFNB's contacts were all at least acquaintances or friends of friends. Instead, he was much more interested in systems that allowed AFNB to connect with people who were already part of a community. However, he stated that ACFB refused their request for food to distribute, citing a difference in organizational structures. He was leery of the degree of reliance on strangers for AFNB's food network; friends of friends and people within a few degrees of separation were preferable to complete strangers.

Buckhead Christian Ministries

Buckhead Christian Ministries (BCM) was a non-profit organization working to prevent hunger and homelessness, partly through their food pantry primarily for low-income individuals and families, who they referred to as clients. Like Alda and Aniston, former BCM's food pantry manager Emma Simmons managed food sourcing and storage. The food pantry was largely stocked with purchased items and food drive donations, but they also occasionally supplemented that with gleaned food. Kim Stone was the interim manager of BCM's over 100 volunteers, four of which gleaned day-old baked goods from Publix grocery stores weekly. Simmons and Stone recalled three unaffiliated people who had donated baked goods every week: one gleaned from a local Costco, one from Starbucks and CVS Pharmacy, and another from an unknown source. Usually BCM only provided these gleaned goods as snacks in their lobby, but sometimes they added baguettes to clients' packages or cakes to clients on their birthday. BCM's policy on perishable food donations was not particularly strict but still liable for perishables, so they generally only received bread and pastries and eschewed meat and cheese.

BCM's managers like Simmons and Stone relied on phone and email to handle most of their interaction with food sources like Publix. Simmons, however, said she hated working over the phone when she managed the food pantry. It often required a lot of time getting to the "right person," such as the store manager, to coordinate their gleaning efforts through transfers and phone menus. These agreements were made on a

more personal level rather than as an official feature of the store. Consequently, in Simmons's experience, some contacts had dropped their (or their predecessors) agreement. While the agreements were in effect, contacts would package their goods in boxes and bags for BCM volunteers, with whom they had arranged for a pickup time (often in the morning). The volunteers would then load them into their car, sometimes to its limit, and drop it off at BCM. Simmons recalled sometimes volunteers were unable to glean all that was available from a source, and other times they would not want to due to the smell of the goods, such as onion bagels from a deli. On this particular donation of bagels, of which the deli packaged hundreds at a time in large plastic garbage bags, Simmons figured its packaging would be off-putting to clients. Instead, they made sure to only reveal them to clients when laid out on a tray as snacks or in clients' packages.

Simmons suggested that a way of educating people on how to package goods for gleaning would be very beneficial to gleaners. She suggested new food licensees could be given guidelines on what they're legally allowed to do with excess food. Food trucks, for example, could then act as both food source and gleaner, keeping food in a safe environment for delivery to a secondary distribution actor like BCM. For corporation and big companies like Publix, Simmons suggested they have better education about reducing their liability for gleaning practices and increase their own benefit. For example, donations could be logged as in-kind donations, which would be important for budgeting and being able to report that as a non-profit. Finally, Simmons suggested having easier ways to connect with food sources, as she had "no good channels to communicate or ask for [donating food]." In addition to a simple repository of food sources, she saw value in ways to codify interactions with those places. For example, she wanted a reliable way to get directly to the "right person," since interacting over the phone was inefficient and frustrating for her. Still, this could not overcome not having enough volunteer gleaners available or store managers reneging on their gleaning agreement. She, like other interviewees, was confident that supply of salvageable foods was not a problem if one knows where to look. Having access to people with attitudes of anti-wastefulness and wanting to provide food for people with limited food access was a boon to making use of this knowledge. This didn't extend to an organization like ACFB, from whom Simmons decided not to take food, because it had so many rules about what and how much BCM could give out, as well as how to qualify people to receive food. The two organizations didn't have compatible philosophies, which in BCM's case Laura described as, "ask as few questions as possible and say yes as often as possible." This was similar to the case of Atlanta Food Not Bombs' interaction with ACFB.

Dumpster Diving

Dumpster diving, also known as “skipping”, can be a secretive practice due to trespassing and property laws making it difficult to access dumpsters legally.

Al West frequently went dumpster diving in Atlanta with several communities. As a volunteer with local social justice non-profit organizations, West received a small stipend per month for food, but they found it preferable to dumpster dive to sustain themselves as a supplement. They lived in an intentional community where people lived together on the basis of shared intents and values, including sharing resources like food.. They would go dumpster diving with a group of at least two people, never alone. Even more impactful than just two people was having a whole community doing dumpster diving so that they knew who needed food or had ideas of how to get food. West referred to their community house as a hub for organizing dumpster diving outings, where they announced usually by word of mouth when they had food to share. If they had someone in particular in mind, they would text or call them.

There are digital tools like forums, maps, and wikis where organizations and individuals share spots for dumpster diving. West was not aware of these, but said they would have been useful. As Aniston of Atlanta Food Not Bombs put it, though, dumpster diving spots are like secret fishing spots and are not something divers would want to share publicly. West suggested that a way to have a secret group online where people could talk about organizing for dumpster diving trips, such as on Facebook, would have been useful. They supposed it could be open, though, to raise awareness and combat the stigma associated with the activity. West preferred Facebook, but they had seen more action on social media sites Tumblr, Instagram, and Twitter. They’ve also found zines on the subject, such as one how-to guide to dumpster diving written by a teenager who was doing quite well by the activity. Using a social network like these, West said, could have improved consistency in scheduling within and between their communities.

When they did organize, they found that having a car was perhaps the most important “technology.” They would drive to places they knew or drive around residential neighborhoods, looking for dumpster to dive for more than just food. West said it was a matter of keeping their eyes open and paying attention to their surroundings to find opportunities. West knew someone who dumpster dived on foot, but they couldn’t carry much and taking public transportation is harder. To West, having a car was key to taking what their communities needed. Taking only as much as they needed was one of the first rules of dumpster diving, according to the people who helped and gave West examples of how to dumpster dive. They also taught West the order in which to check different places’ dumpsters, especially large grocery stores. Aldi’s was often their first stop,

because there was no scent around the dumpster and it was easy to access. They also knew other divers would go there because they would find things left outside the dumpster for others to take, presumably because the previous divers had taken only enough themselves. Whole Foods, by contrast, was harder to access, because there was a fence surrounding the area with the dumpsters. Large grocery stores often also are locked trash compactors that can't be accessed by dumpster divers. West said people also would be suspicious, thinking they were "hooligans" sneaking behind buildings. Suspicion and trust were major obstacles to remediating the stigma of dumpster diving. The houses they lived in was a community of people who also joined, so they did not have to worry about judgment or stigma. Anyone can do dumpster diving though, according to West. "A flashlight, [pocket] knife, dress appropriately and have a car and have a buddy," West said, "That's pretty much all you need. And some gumption."

Society of St. Andrews

Society of St. Andrews (SSA) was a Christian organization somewhat similar to BCM but focuses more on field gleaning. Whereas other organizations are focused on gleaning as a modern post-distribution activity, gleaning from a field or from harvested but unprocessed produce is the traditional post-harvest method that has persisted for millennia. It also directly improves food security as the outcome is access to fresh and healthy produce and is directed primarily to people who are food insecure.

SSA operates as a national organization with state-level area coordination. For example, Florida, a state that produces much of the country's produce, had five area coordinators and a state director. Taylor Bale, formerly one of those area coordinators, was the program coordinator for south Georgia. In this role, she found people interested in gleaning, especially large fields of produce, and planned gleaning opportunities. She also coordinated SSA programs like Harvest of Hope that focused on educating participants about local and global hunger issues.

Similar to Alda with ACFB, Bale was primarily a networker. The most limiting factor was SSA and farmers knowing the other exists. Bale's first step was contacting farmers to explain SSA and then ask permission to bring volunteers to glean any food they may have. An important point to mention was that they'd be protected by volunteers' liability waivers. Other farmers would also hear about SSA by word of mouth and would call them when they had truck loads of produce that had been refused by buyers. Even a small surface blemish caused by farm pests would reduce its attractiveness on store shelves and would not pass the standardized quality requirements for retail. Produce would be automatically and manually sorted into boxes for marketable produce, and imperfect produce would often go into a dump truck called "coal bins." This was reportedly

especially the case with green beans and potatoes, which many stores often subject to strict length and shape requirements. For large commercial farms, this could affect tons of produce per harvest. For smaller CSA farms and urban gardens, there was little to no waste that couldn't be repurposed on the farm, such as for animal feed.

She often had only a few days to get the word out to farmers and volunteers and then to glean the food. Having access to communities and social networks was most enabling to this rapid networking task, though she admitted that she did not use social media as frequently as she could. Bale also considered SSA's website highly useful to inform farmers about gleaning and to sign up volunteers to email lists for each area of the state, as volunteers usually didn't want to travel more than an hour to glean. Rather than directly contacting each farmer, the optimal situation Bale said would be to establish long-term relationships and work with them to set up a gleaning calendar based on their growing and harvesting seasons. Having access to farming and gleaning communities helped her get groups together, mainly by email. Before those groups arrive to glean, Bale and the farmer would agree on a gleaning schedule and go to the farm to handle obstacles like drainage and safety issues and to determine what they would pick and how. When the gleaners arrived, they would distribute tools, pick produce from the field, and then load into trucks or individual volunteers vehicles, depending on the amount of food gleaned.

Once they finished on the farm, they would drive the produce to food banks, soup kitchens, and other agencies with loading docks. The state food bank association would help coordinate this networking step. One such place was a "food hub" that Bale described as "like a food bank on steroids." Unlike other large food banks, it had sections for sorting, freezing, canning, and boxing produce, storage for these packaged goods, a commercial kitchen to prepare and teach people how to cook fresh produce, and loading docks for distribution via large- and small-scale transportation. It also acquired food from as far as North Carolina, compared to just the Atlanta Metro Area for ACFB. Most food banks didn't have these facilities for acquiring fresh produce, and those that did could be overwhelmed and challenged to distribute it while still within the "window of sustainability," according to Bale. This was especially important in cases such as where a farmer donated a truckload (over 40,000 pounds) of cabbage rather than dumping it in the woods, as was common practice in rural areas where the cost to properly dispose of it was too high.

Finally, Bale would record the weight of all food gleaned by SSA, broken down by amount sent to each agency or taken by individual gleaners. Combined with other area updates, this information would then be compiled into reports in Microsoft Word format and submitted to the state director and then to the national office. The national office

stored all these details in their database, which would then be used to generate reports and annual receipts to farmers for tax purposes.

DISCUSSION

General Tool Comparison

Gleaning is an activity that involves many digital and nondigital tools and services, used in Atlanta and beyond, for gleaning-related activities. Whereas much literature has examined non-digital tools, this study sought out digital media used in gleaning. We produced a series of diagrams to describe both the food systems under study and abstracted diagrams for comparison to other systems. There are dozens of digital tools, a list of which are compiled in Appendix A, including many maps explicitly for gleaning and websites with information related to gleaning. These tools are used for and between categories of gleaning activities, modifying how food flows between actors. This is pictured in Figure 1.

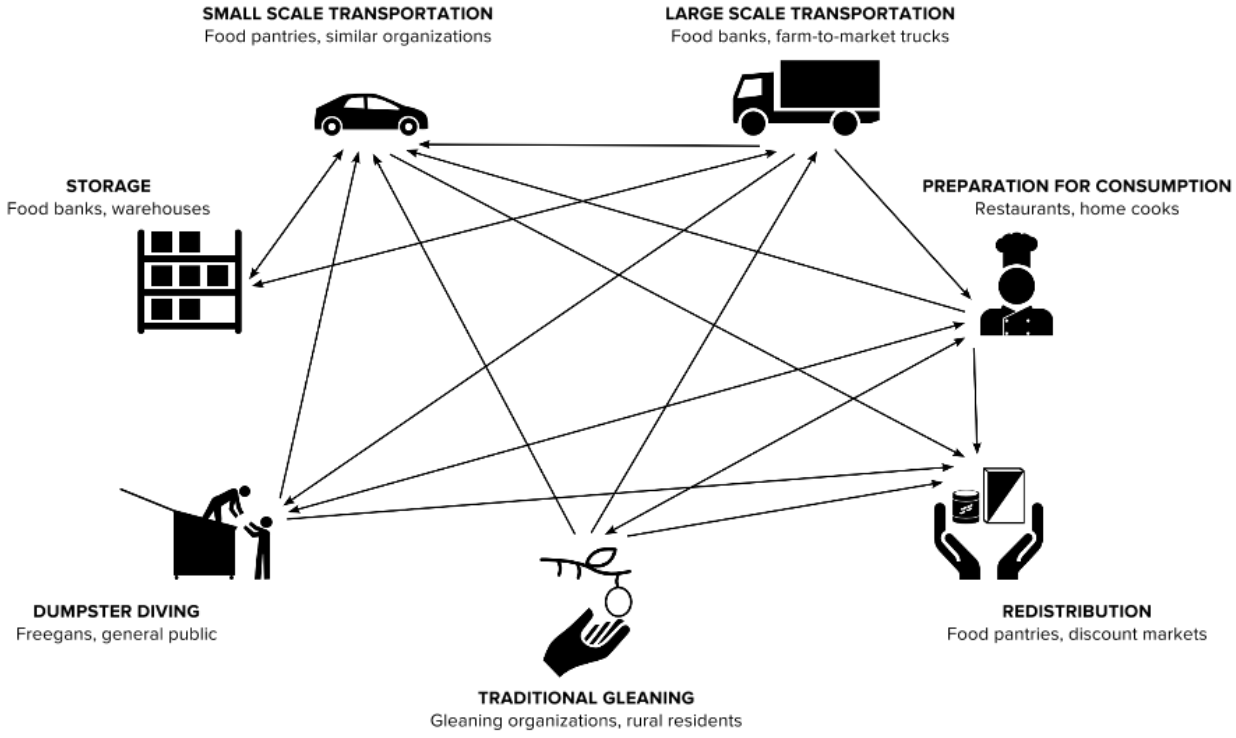

Figure 1: Flow direction of food between activities involving gleaning, clockwise from top-left: small-scale transportation, large-scale transportation, preparation for consumption, redistribution, field gleaning, dumpster diving, and storage. Relationship management is not pictured, but it is present in each flow.

Appendix B provides a matrix view of this diagram using existing services as examples of flow, which Appendix C provides more insight to how technology is used by each service. The categories of gleaning activities derived from past studies and this study's

interviews can also be applied to these general (non-localistic) tools, as well. The most high-volume services and tools bridge multiple categories, including Food Cowboy, CropMobster, and Feeding Forward.

General Themes

Many tools are used between different activities, particularly in socio-technical networking and mobilizing small-scale transportation, suggesting that something usable in multiple, or changing, contexts would be valuable. In addition to tools, four general issues were common among the interview participants: outreach, mobilization, trust, and education.

Outreach

All interviewed participants seem to know there's more food available "out there" to glean, but don't always know how to confirm that or better reach out to others who may know more. Knowing that food is available is difficult. West was involved in several communities and groups in Atlanta, and whenever food was leftover from a meeting, they would use their personal contact lists to figure out what to do with it. West would even join church groups they weren't formally affiliated with and take leftovers to people they knew, personally and incidentally, needed food and called it "paying it forward." Knowing people personally was invaluable to both West and Aniston, who maintained relationships with people in restaurants, since they save food from being wasted before it ever makes it to the dumpster. Many of these dumpsters are locked or on private property, meaning accessing the dumpster can be prosecuted for trespassing. Reaching out to people in the food industry is important for mediators, like food banks. Alda and Bale made a full-time job out of just maintaining and seeking new relationships with food sources. However, in the gleaning food system, the secondary distributors like food pantries may not always have access to these mediators. In Aniston's case, he wasn't able to qualify as an agency for ACFB to distribute the food it recovers because AFNB is not formally organized, according to him. BCM chose not to reach out to ACFB as an agency, because they did not want to adopt their strict rules. Rules aren't always barriers to outreach with organizations, though. In West's case, they knew that their community used to have a relationship with a community-supported agriculture (CSA) group that would give a lot more food to their house than other clients. Normally CSA uses a shared risk model that incorporates more communal rather than capitalistic rules for its distribution policy. Bale, too, worked with community-based agriculture and hailed a recent urban agriculture ordinance (Atlanta City Council, 2014), all to better attract gleaners in this personal context. West was also involved in other communities dedicated

to distributing food collected and prepared for distribution to local neighborhoods. This ability to connect to entire communities, though, were strongly linked to how well they could mobilize many people at once.

Mobilization

Whereas the interviewees all had their known pick-up, drop-off, and storage locations, they did not always have the means to move gleaned food from their source to someone who could use it. Instead, they were reportedly only able to mobilize people for certain legs of the food's journey. For example, ACFB has many food sources throughout Georgia, one storage facility, and many agencies for distribution, and Alda said they often had to sacrifice some gleaning opportunities for others based on their truck fleet's capacity and routes that day. Fresh produce was often handled far outside the city of Atlanta at the food hub Bale described, but SSA had to coordinate the entire state from one office. West didn't have access to a car at their house for years after they started dumpster diving until a car-owning roommate joined. They also had a lot to say about what could have been if they could mobilize and schedule more people at once; however, their conflicting schedules and business often thwarted their ability to scale their efforts. In addition to organizations' resources, the food itself has an expiration date. Even if there is a possible route over some time, the food must be kept from spoiling during this journey. The organizations with more support were able to support more centralized space to store food, from deep freezers to entire warehouses. Gleaners can be significantly limited by this logistical problem, although they were usually able to keep some of the produce they gleaned for themselves. This can be a powerful motivation, although they were still unlikely to participate if they had to travel far.

Trust

More fundamental than their abilities and goals, trust can influence a lot about these organizations and how non-members regard and interact with them. SSA's faith-based mission likely enabled them to establish a personal relationship to farmers, communities, and individuals who share the same values. Whereas in AFNB's case, their philosophy and affiliations with anti-authoritarianism worked well with people involved in social movements, but that could hinder relationships with formal organizations and government, despite their interest in always attracting people to join their cause and activities. Organizational structure, too, can clash with that of others, such as ACFB's refusal to distribute its food to AFNB. Aniston himself was leery of trusting people they don't know to certain degrees in their gleaning network. However, their preference for personally connecting with communities would allow for access to more people within fewer degrees of separation once trust is established with key contacts. Since these

groups aren't legally bound to their reasons for interacting (or not) with each other, establishing trust between organizations could be greatly influential and perhaps easy to facilitate to connect gleaning organizations and gleaners. In BCM's case, store managers were critical to their ability to glean from a large enterprise like Publix. The support of a manager could mean the difference of a car full of bread every week. Considering corporate and individual stores' policies, though, this could incur too much risk for both the store manager role and the gleaning organization's reliance on this source. Similarly for individual contacts, like AFNB's contacts at restaurants, if this trust and education isn't maintained by the organizations, it may not be transferred to subsequent people in these roles. Among the communities West was in contact with, there was a strong trust among them about packaging and sharing gleaned food.

Education

Similar to issues of outreach and trust, educating people about gleaning is perhaps the most important. Wasting food is more common than gleaning it, and the legal grey areas reduce the visibility of gleaning. In the case of dumpster diving and preparation for consumption, it's more of a health case, whereas safety is a top priority for gleaners on a farm and managers of large stores. Despite that, those who are both aware and capable of gleaning food require little information more than knowing what to do with salvageable food waste. Bale reported that once farmers understood SSA's capabilities, they were quite receptive to field gleaning and often shared information with other farmers. Public perception of gleaning is another form of trust that could perhaps yield the greatest benefit in scale. If everyone were open to providing their surplus food to potential gleaners, then BCM's deli contact may be more likely to provide bagels in a branded box instead of a garbage bag, West may have an easier time separating gleanable food from spoiled or rotten food, and Bale could better mobilize gleaners across the state. However, if the public perceives gleaners as untrustworthy or "hooligans" as West put it, then the stigma of both gleaning and making surplus food gleanable would likely persist. Similarly, West and their communities were taught by others the social mores of dumpster diving, mostly targeted toward other divers but also to the site of the dumpster. The dumpsters at Aldis were often their first stop for reasons described, and the etiquette of not leaving a mess and letting surplus food from one diver's haul be more accessible to the next diver is an example. However, businesses that are perhaps over-cautious about dumpster diving could be made more aware that compactors and fences make dumpster diving an illegal or inaccessible activity. Simmonsn suggested that when businesses go through their initial food licensing procedure, they also get some educational information about donating their food, especially how to package it for donation. She said that even though information is available, managers were unsure whether and how to get involved with BCM without

some convincing. This difference in whether an organization relies on an individual versus a role in a food source is most important when access to gleanable food is held by the latter.

These issues were common among the other tools and organizations surveyed (Appendix A). Food Not Bombs is a loosely organized national collective of local groups, so some issues may be more or less important in other cities. The same applies to food banks, church organizations. This discussion was centered on findings from Atlanta but could be applicable to other cities. Further investigation would be useful in connecting not just organizations within a city, but between cities as well. Although the reach of these organizations may not span past the city limits often, organizations like food banks and networking applications like Food Cowboy could be an important facilitator for increasing collective reach.

DESIGN IMPLICATIONS

The problem space framed by this survey is the disparity between food access and food production. In this section, we scope out the implications for both the sociocultural interactions involving gleaned food and the human-food-interaction that Comber, et al. (2012) called for to address issues in their design space. The related works we cited call for digital platforms for food opportunities (Bohner et al., 2009; Lyle et al., 2015), mediating technologies for food system interactions (Clear et al., 2013; Hirsch et al., 2010), and tools for improving self-sustainability (Chang et al., 2014; Heitlinger et al., 2013). Combined with our findings, we suggest that most challenges in gleaning is related to networking issues. These issues have organizational, public, and personal design implications.

Organizational Internetworking

Organizations for gleaning try to compensate for the systemic failures of food systems that fail to provide security, often due to inadequate geographical and economic access for vulnerable populations. However, these organizations are also inadequate at fully compensating when they do not work together. They tend to form their own networks with both inclusive and exclusive criteria, with larger organizations like food banks tending toward inclusivity. This leads to disparate, even disconnected networks of actors seeking to improve food security. Zobel et al. (2016) found that technologies have been highly effective in other industries' supply chains for coordinating and sharing information between entities, and could be just as valuable for networks of gleaners. Exclusivity is a major consideration to designing an effective solution to connect networks, which together could better mobilize resources and reach out to more potential gleaners.

More abstractly, there are issues and inefficiencies in node discovery and path cost optimization. Food is the information being shared in a peer-to-peer (P2P) food network, where nodes are actors and organizations that face some cost of moving food between each other. CropMobster and Food Not Bombs are constrained by geography and tight personal networks, respectively. Mesh networks (Lua et al., 2005) could eschew these constraints while preserving many of their benefits. For example, the messaging application FireChat uses a topology that accounts for a dynamic set of available peers to move information. As peers join and leave FireChat's network, each message is still able to hop through them until it reaches its intended recipient. Similarly, a reliable set of organizations like food banks and their contacts form a predictable, semi-permanent network, whereas actors like dumpster divers and occasional volunteers provide more ephemeral connections within the network.

Public Networking

Helping to some degree here are dozens of tools and services that can organize and educate the untrained public to participate in gleaning. These have largely been relatively simple digitizations of previously non-digital technologies, like maps and information repositories. Many have also leveraged internet and inter-community networking technologies to increase the accessibility and speed of gleaning. A problem with gleaning network technologies in Atlanta is not the quantity of food to glean, people to mobilize, or places to find food, but the knowledge of all of three at the same time. Instead, for example, a gleaner may know when a grocery store usually tosses out certain food but not how much or whether there would be any left by the time they got there, reducing the ability to plan and act at critical times.

The proliferation of peer-to-peer civic technology (Knight Foundation, 2013) suggests there could be systemic optimizations in a digitally mediated network and user-centered design opportunities to contextualize the system to a public. In order to entice people to join this network, the participants in our study (and cited studies) seemed to rely on strong philosophical convictions to participate in food systems this way, as well as getting a cut of the gleaned items. They may have direct access to the gleaned items via field gleaning and dumpster diving, a free store like AFNB, or programs like SSA and ACFB. The three high-volume non-localistic services described in the general tool comparison section are also strongly marketed versus simpler platforms like LeftoverSwap. However, one design consideration here is trade-off between centralization and distribution of the service. These services all have the benefit of popularity through their managing companies, enticing more people to join and thus share food; however, they also may fail to localize their service to the nuances in individual food systems, making it vulnerable to the same inclusive and exclusive drawbacks previously described. Instead, it may be

worth considering a distributed knowledge network that can be localized and customized but still be accessible by similar applications. This perspective is more of an "infrastructure as a service" (IaaS) rather than Food Cowboy and Feeding Forward's "software as a service" (SaaS) (Manvi & Krishna Shyam, 2014; Rodero-Merino et al., 2010). We suggest further research into how concepts like these could apply to human-centered computing and low-tech organizations like AFNB and SSA.

Personal Networking

Ericksen (2008) called for greater understanding of individual agency in food system interactions, citing the inconsistencies in ecological, political, and food security goals. In addition to timing, mobilizing people in the first place could scale more easily if trust and education issues were resolved. Dumpster diving and explicitly leaving food out to be gleaned tend to raise suspicion, borne out of legal and safety precautions. However, as the participants and literature have related, these suspicions are poorly founded and at times counter-productive to gleaning practices of community food security.

By raising awareness through more widely trusted channels, like social media and more direct forms of ICT, it may be possible for a hotter medium to educate and engage non-gleaners. For example, a service that suggests picking up food from a common gleaning source and moving to a common destination, both on or near a route they frequent, would both directly contribute to gleaning efforts as well as more comfortably introduce non-gleaners to the practice.

CONCLUSION

The U.S. experiences a significant disparity between food production and food access, affecting millions of people, especially the poor. This difference is mitigated by gleaning, practices of which in Atlanta are described in this survey. The findings of our survey exposed issues and opportunities for design interventions in the interactions between activities and among actors. The most common issues in Atlanta are related to networking, particularly in discovering new sources and destinations of food and the capacity and availability of actors to move food between them. Since gleaning sources (e.g. grocery stores) and destinations (e.g. food pantries) are rarely co-located, moving food is almost always necessary and often occurs in amounts that require a vehicle. This leads to another issue of being unable to plan for and do gleaning when all knowledge of and capabilities to do so are available, leading to food waste even when the people involved intend to salvage it.

Further research may involve more in-depth case studies of organizations and tools described here to understand how they may be individually affected by networking

technologies. We see value in developing a more robust model of gleaning by similar surveys in different cities' food systems. Literature reviewed included location-specific nuances that could not be studied in Atlanta. Understanding both local gleaning efforts and more general gleaning practices would be essential to developing digital media that seeks to improve food security and prevent food waste as it spans disparate food systems.

DESIGNING GLEANHUB

SUMMARY

A major design opportunity for gleaning is related to socio-technical networking: the processes and infrastructures for providing information about the availability of food for gleaning and access to the actors who can move and store gleaned food. This section presents the design iterations and evaluations of a service architecture and mobile app called Gleanhub.

DESIGN SPACE

The problem space described by my formative work is the disparity between food access and food production. Gleaning has long been a limited solution that salvages surplus, helped along with ubiquitous technologies that have largely been relatively simple digitizations of previously non-digital technologies, like maps and information repositories. Many have also leveraged internet and inter-community networking technologies to increase the accessibility and speed of gleaning for organizations. Gleaning involves many digital and nondigital tools and services used for and between different activities, particularly in socio-technical networking and mobilizing small-scale transportation. This suggests that something usable in multiple, or changing, contexts would be valuable.

Four general issues were common: outreach, mobilization, trust, and education. Knowing that food is available is difficult due to social and technical barriers and lack of awareness of organizations with outreach campaigns. Whereas gleaners often have set pick-up, drop-off, and storage locations for food, they do not always have the means to move gleaned food from their source to someone who could use it in a continuous process. More fundamental than their abilities and goals, trust can influence a lot about gleaning organizations and how non-members regard and interact with them. Finally, educating people about gleaning is perhaps the most important in mollifying stigma and avoiding misunderstandings about alternatives to wasting unsalable food. The general problem with current gleaning network technologies is not making best use individually of the amount of gleanable food, people to mobilize, or places to find food, but the availability

of each of these at certain times. It is also the ability to do so with limited resources, even compared to nonprofit organizations.

DESIGN ITERATIONS

In the following sections, I present the iterations on design alternatives including kiosks, websites, mobile applications, application programming interfaces (APIs), and other sociotechnical infrastructure. Some of these designs were developed during the formative process, as I indicate in the following sections, and the final iterations were developed after.

Iteration 1: Kiosk + Website

In March 2012, before most of the formative research phase, I worked with my colleague Jihye Shin on an interaction design project from the perspective of collaborative consumption and food issues. We briefly researched networking between those who can provide and share food, and those who seek food to glean. This helped us define four user groups for our networking service, for which we designed personas and scenarios:

- **Farmers**: grow produce that is sometimes ugly or otherwise unsalable, or perhaps grew more than was needed on the market, easy to network with
- **Food retailers**: restaurants, grocery stores, and convenience stores, all compelled to treat their food products as liabilities with finite shelf lives, easy to network with
- **Impoverished people**: glean by necessity, can be easy to very difficult to network with depending on their availability and contact methods
- **Casual gleaners**: glean food for anti-waste or low-cost reasons, like freegans

We designed scenarios for each of these personas and developed a low-fidelity prototype (Appendix D) meant to be implemented for both web (for people with computers) and physical kiosk (for people with minimal computing resources). After critiques by our peers and professor, several iterations on our design, and more research on the background of its implementation, we developed a higher-fidelity mockup (Appendix E) shown in Figure 2. Finally, we acted out two scenarios in a video[1] that includes a walkthrough of the prototype.

[1] http://youtube.com/watch?v=s7JmHAvNVKQ

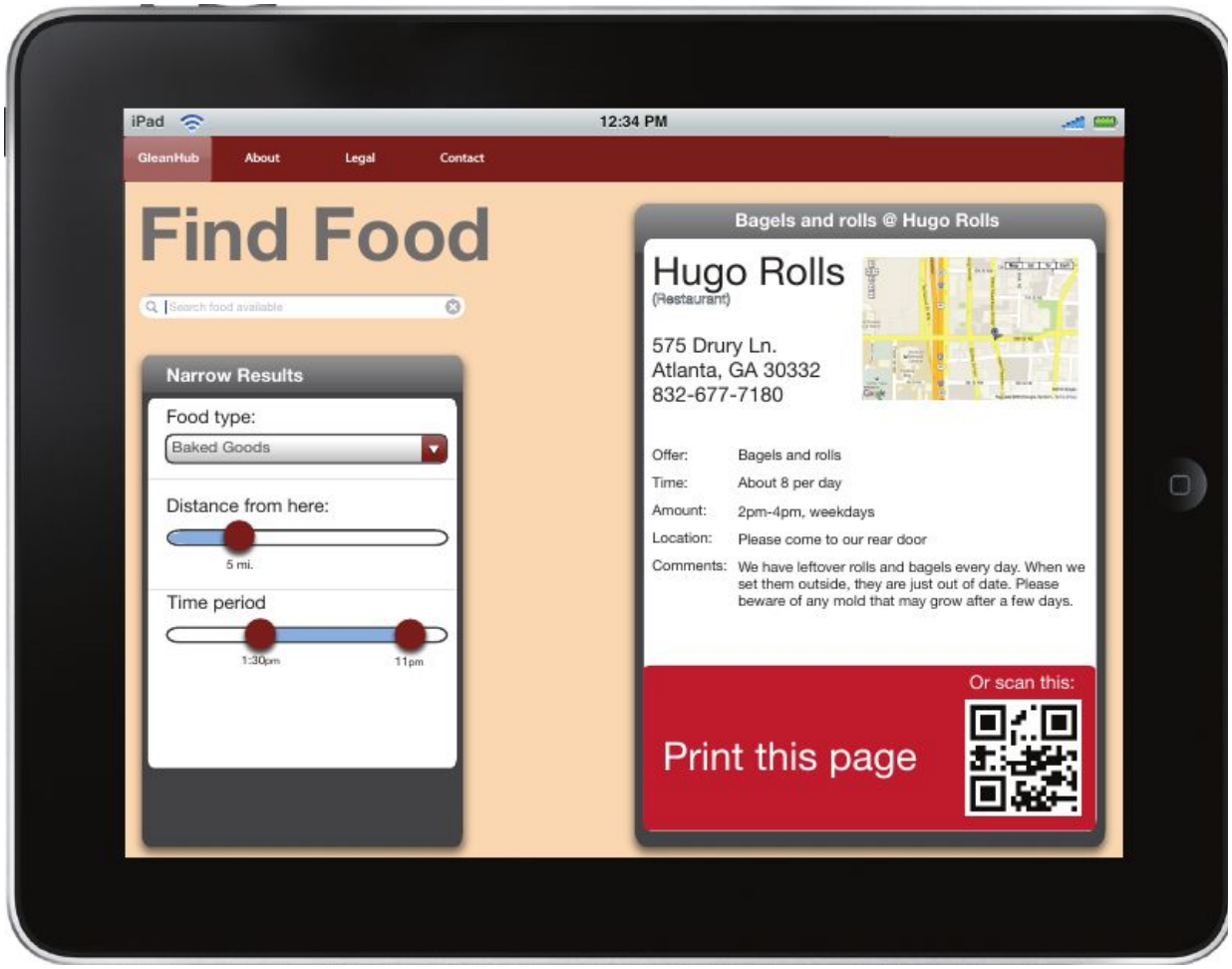

Figure 2: A high fidelity mockup of a kiosk or website concept for finding food to glean

Iteration 2: Public Kiosk

In November 2014, I rebooted the Gleanhub concept with Code for Atlanta, a local civic hacking organization, to continue to explore the design space for gleaning services. Whereas organizations like food banks manage large-scale functions and data, I wanted to know if the public could do this as well. My primary research questions were:

1. Would farmers and food retailers make their extra food available easily? How could this behavior be incentivized?
2. What is the most sanitary way to make food available? What trade-offs arise when certain foods need to be handled a certain way? For example, some food ought not be eaten when left exposed outside overnight. How can this safety information be included with the food as it is made available? Knowing expiration dates by environment would be especially helpful.
3. How would food providers advertise their food's availability?

4. How can information about salvageable food be best disseminated to people who would use that information? What information is important for whom?
5. What good would this crowdsourced data be if the density of salvage reports is too sparse? I'm thinking of deploying this on a per-neighborhood scale to ensure the usefulness isn't diluted by geography.

This initiated the formative research presented in the previous section while I also designed alternatives to what I found. I took these questions and the initial Gleanhub concept to the Govathon, a civic hackathon put on by the City of Atlanta and Atlanta Workforce Development Agency. The attendees included business leaders, public officials, and people familiar with the problem space. This included people involved in the Atlanta Streetcar construction who were searching for concepts to include in kiosks at stops. These people provided ample feedback on my work to date and the team work done at the Govathon. This included an iteration on the kiosk concept with my teammates Ying Yao, Cindy Wang, James Arsenault, and Sriram Balasubramaniam. We decided to focus our work on the public awareness of food insecurity and waste while providing people access to certain channels of reclamation. Paramount to these needs is the low barrier of entry to the system so that we would not require too much of a behavioral change mediated by our technology.

For people who would share food, it would be the responsibility of special users, which we called "Advisors," to contact businesses to improve their food safety practices for gleaning, such as using fresh plastic bags to keep edible produce together and unsullied. For gleaners, it would match them with food drop-off places using a kiosk at streetcar stops, SMS, or a website. These drop-off places would also broadcast when food is deposited there so that people would not simply congregate around it all day. In addition, to prevent false positives of food availability, each time a potential user would check a place for food, the system would increment a view count that would display alongside its post time. Together, this should indicate how likely the posted food has already been gleaned.

We created a different experience for each user group, considering their needs and workflow. Yao and Wang created the mockups for them in Illustrator, which I then linked together in two interactive mockups using Invision: a kiosk for gleaners[2] (Figure 3) and a website for givers[3]. We put together a presentation, delivered mostly by Arsenault, garnering praise from Atlanta's city officials and civic innovators and earning us second place out of a dozen teams.

[2] https://projects.invisionapp.com/share/H71QIFVQ5#/screens
[3] https://projects.invisionapp.com/share/W61QIG4A4#/screens

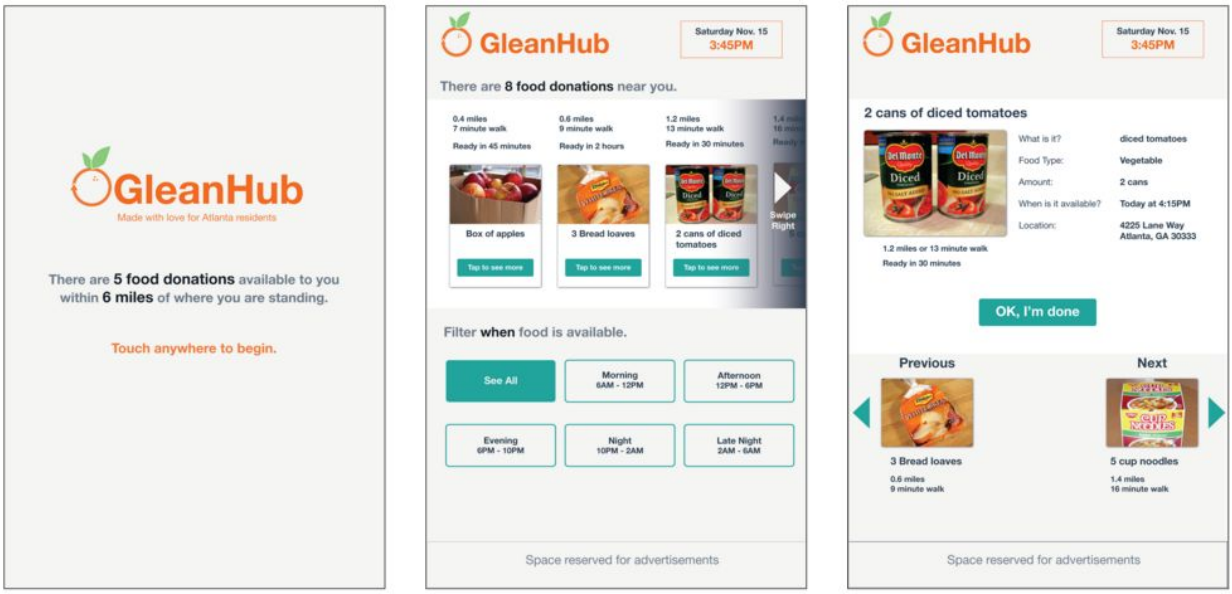

Figure 3: High fidelity mockups of a kiosk at public streetcar stops.

Iteration 3: Networking Technology Ideation

Prompted by the feedback from the first two iterations, I sought to better understand the problem space in Atlanta. I conducted a majority of the formative research into this space during this iteration and challenged a number of assumptions. Most significant was discovering that the most common issues are related to inter-networking between groups that do gleaning but don't normally talk to each other. The problem with existing gleaning network technologies is not the quantity of food to glean, people to mobilize, or places to find food, but the availability of each of these at certain times. Framed by interactive computing, my track in the M.S. HCI program, these are issues and inefficiencies in node discovery and path cost optimization.

To draw analogies, information is in the form of food being shared in the system, and nodes are actors and organizations that face some cost of moving food between each other. From this perspective, I considered how a solution could be phrased in less contextual terms to allow for more collaboration outside of Atlanta and even food systems. For example, the company MedShare uses a similar system to deliver surplus medical supplies and equipment to hospitals. Since 2000, there has been a steady growth of the number and investment in community organizations that develop technology for civic outcomes (Figure 4). Projects that promote peer-to-peer sharing experienced the most growth and investment, though over two-thirds of this investment went to only a few companies (Patel et al., 2013), demonstrating business models were probably paramount to social impact. Still, the clear interest in sharing economies at different scales demonstrated a fertile space for new services.

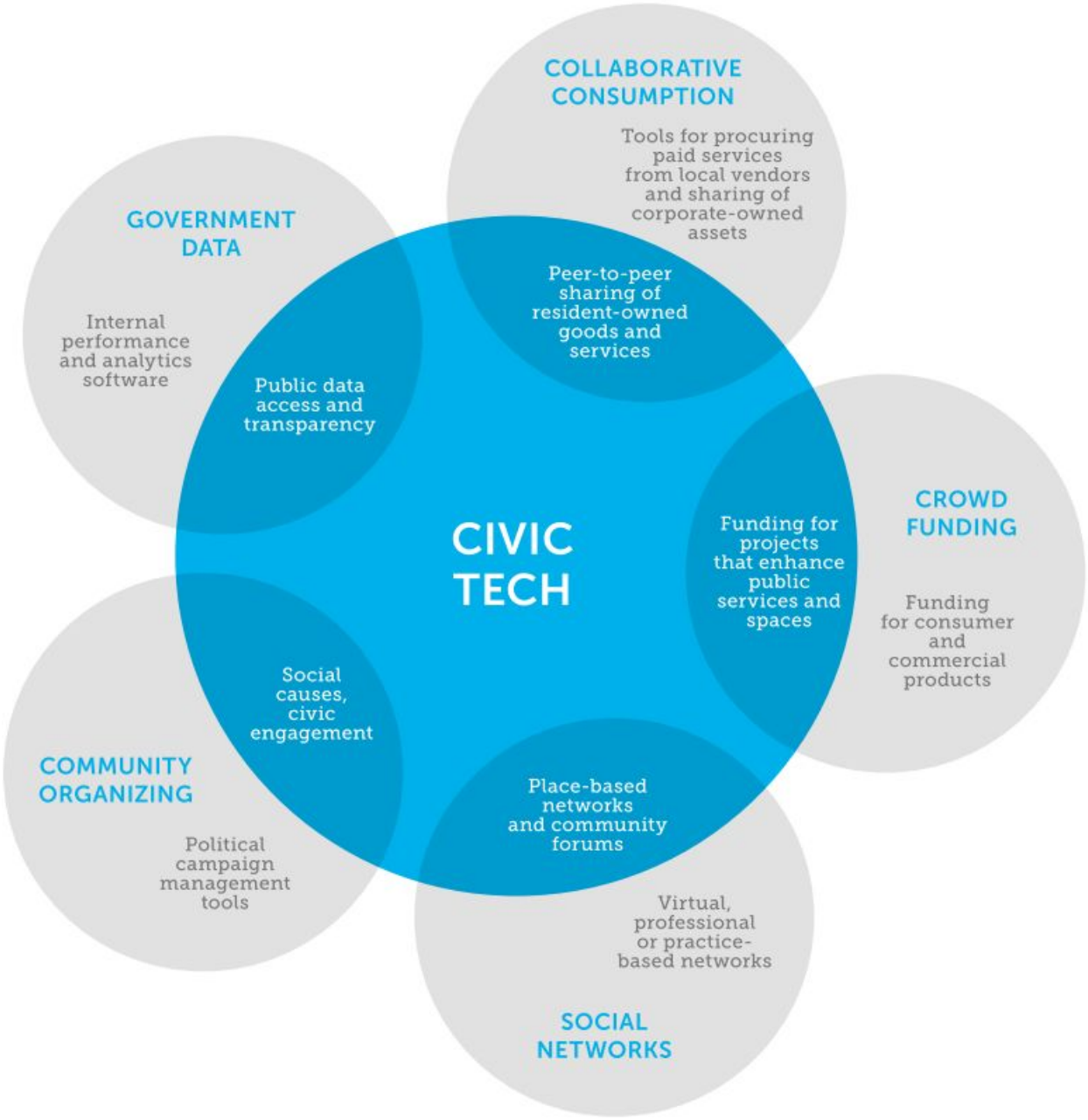

Figure 4: "Civic Tech: A Convergence of Fields"
Source: The Knight Foundation (Patel et. al, 2013).

By building off of the proliferation in peer-to-peer civic tech, a solution to gleaning issues in food systems could be designed as a peer-to-peer (P2P) network, using computer science and graph theory to suggest systemic optimizations and user-centered design to contextualize the system to a public. This would take into account the kiosk, website, and mobile touchpoints that I had explored previously.

Much of the literature on gleaning practices is found in the context of local food (Vitiello et al., 2014; Martinez et al., 2010), but “peer-to-peer” doesn’t necessary mean it limits people to sources within a state, county, or social network. Current projects like CropMobster and Food Not Bombs are constrained by these, respectively. Fault-tolerant mesh networks employed by messaging services like FireChat use a topology that accounts for a dynamic set of available peers to move information. That is, instead of a common client-server networking scheme, as peers join and leave the FireChat network, each message hops through phones Bluetooth range until it reaches its intended recipient. Analogously, a reliable set of organizations like food banks and their contacts would form a semi-permanent network that transient participants can use to hop food from one place to another.

Overlaying that existing network could be a layer of abstraction that helps these less reliable or even incidental peers, such as weekend volunteers and good samaritans, to participate and provide instructions on how to join the network with little opportunity cost. What if gleaned food could also be exported or imported to different local food systems? This would provide a more reliable network that could span multiple localities and boost the availability of resources for gleaned food to move through food systems, local or not. There are many other peer-to-peer overlay network schemes that could be applied to food systems, but the overall perspective is what’s most valuable when considering the service’s design (Lua et al., 2005). That is, such a service that could aid in the timely networking of actors in food systems to facilitate moving food from sources to destinations could be of significant help to formal and informal organizations alike.

My plans for my this iteration fell through after determining the scope of work with the School of Computer Science Chair, Professor Ellen Zegura. Her feedback was that it was an interesting approach but the technology involved would require a significant amount of work to implement and extend to this use case. The idea was also difficult to analogize for direct evaluation by my stakeholders and may merit its own project. The idea, though, persisted through the rest of my project to inform how future work may be made possible and to inform the infrastructure for data management.

Iteration 4: Web Service

I decided to focus my development work on creating an open version of the Feeding America food bank network’s current information sharing system. The food bank sourcers I interviewed indicated that their own system is not open, because they are forced to follow strict rules of corporations like ConAgra and Kraft due to a host of regulations and accountability issues. Comparing their system to the other more open

systems that I compared in Appendix A, I developed an information model and API that would host reports of food opportunities.

Using common open-source tools, I set up a database, API, and mobile interface on my personal server and shared this on Github, a website that hosts open-source projects.

Database

The database was built using MySQL with two tables: one for user credentials, and one for food opportunities.

The former was not fully implemented due to the prototypical nature of this project, but it was accounted for and kept in mind when making other design decisions. Its fields would have included the following:

- id: for faster integer-based identification of users
- username: for uniquely identifying users, primarily for human readability
- isVerified: signifying that the user is a verified user, not a bot
- isAdvisor: signifying that the user is an advisor, as described in Iteration 2
- info: a text field allowing the user to write about themselves

The latter table, for reports of food opportunities, is used to hold the following information:

- Id: for unique identification of the report
- Datetime_reported: automatic timestamp of the report submission
- Availability: Time range of the pickup area
- Notes: Notes or instructions the owner may leave to the gleaner
- Place: Friendly name of food pickup area
- Lat: Latitude of food pickup area
- Lng: Longitude of food pickup area
- Owner: id of user who owns this food opportunity
- Visibility: Public ops are visible to all, limited ops are visible to owner and advisors, closed events are visible only to owner

API

To expose this data model to the public, I wrote a simple REST (representational state transfer) API to allow human operation in a common web browser and machine operation through common web service methodologies. Users in a browser and special querying tools would be able to modify the data this way, and programmers would be able to use

the same service in applications. I used this API in developing a mobile interface to allow for more human-centered computing tasks.

Mobile Interface

With these web services in mind, I used Axure to create a set of interactive wireframes[4] for a very basic mobile interface (Figure 5), as most gleaning activities involved being mobile.

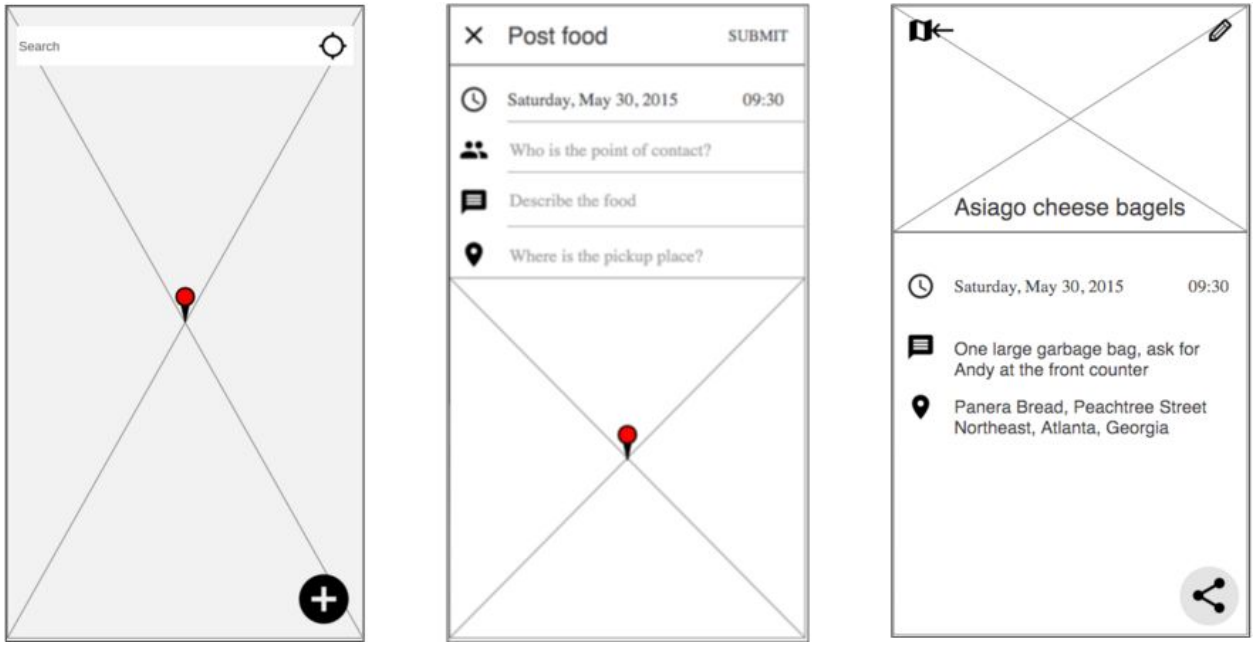

Figure 5: Wireframes for a mobile reporting interface

I originally developed this and a similar concept with Ali Hussain Kazim, Florian Foerster, and Sherjeel Khan at another hackathon for Pakistan, called Pakathon. My team was figuring out how to best collect and preserve data on the incidence of bribery in Pakistan, so we developed a mockup and spent quite a lot of time on a prototype of the app that was simply a localized version of a generic mobile map input-output app. So my first prototype of this mobile interface was initially inspired by what a generic interface may look like slightly tweaked to fit the gleaning context, as pictured in Figure 5.

We presented this to our mentors in the Pakistani and American tech domains at Pakathon and got some feedback about the social appropriateness and technical considerations for such a service. This was around the same time I was wrapping up the formative research. I used this feedback as related, but not directly applicable, knowledge on designing a mobile civic interface. I chose to consider a mobile interface

[4] http://8zj0cm.axshare.com

from the generic perspective, as it may be a common touchpoint in the design of a service versus a single application. Gleaning takes place over different times, spaces, contexts, and sociotechnical interactions, so having a common boilerplate interface from which to “fork” into interfaces more fitting to a combination of each. I called this iteration “mobile-map-io” for users that are mobile, using a digital map, doing basic input and output tasks with the web service previously described.

I continued developing this application and the web service into a working prototype using Javascript and Ionic Framework for UI elements. The code is available on Github[5].

Iteration 5: Gleanhub (Mobile Web Application)

From this working prototype of a web application (app), I began customizing the interface to fit the context of gleaning (Figure 6).

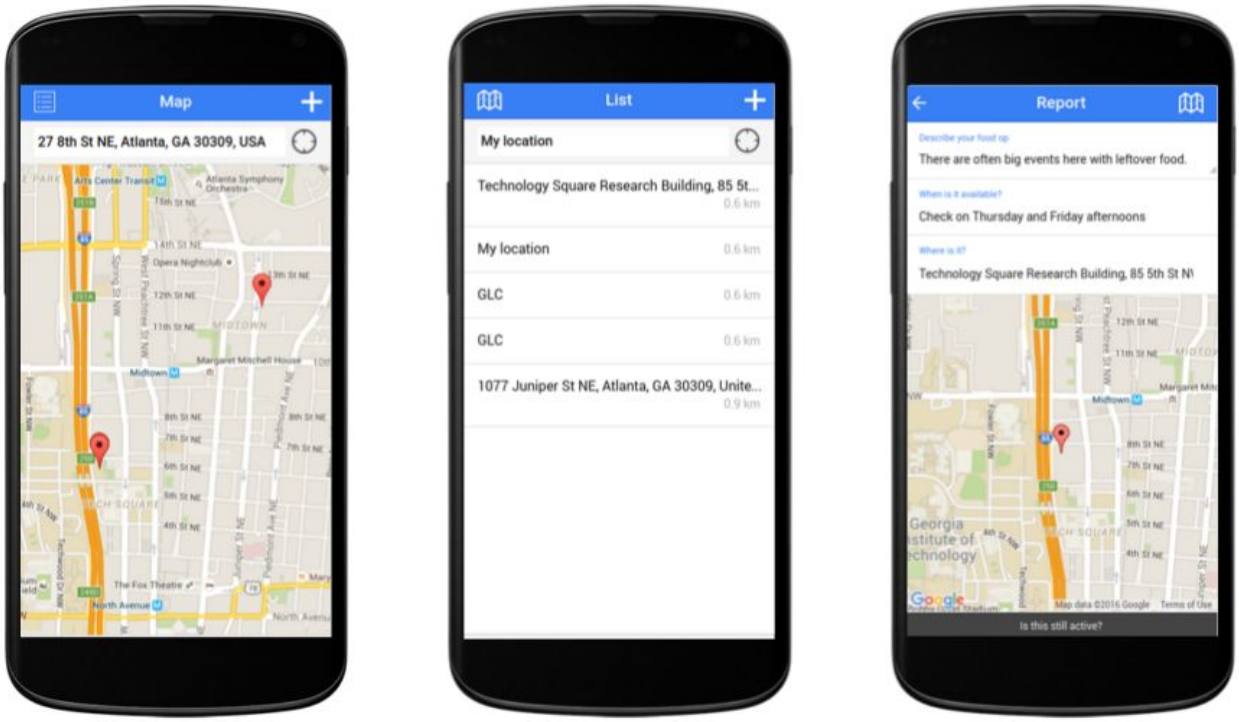

Figure 6: Screenshots from an early working prototype of Gleanhub, the mobile web application

This was also pushed to Github[6] and I created a video[7] of the phone screen walking through two scenarios: posting leftover pastries at a coffee shop, and searching for food to glean. I used my notes, photos, and videos of how participants in my formative work

[5] https://github.com/werdnanoslen/mobile-map-io
[6] https://github.com/werdnanoslen/gleanhub/tree/4ce2a422f2b46502df4d560c6117ad614982e84e
[7] https://youtube.com/watch?v=pwq0uc14YoE

conducted their gleaning practice and created an initial set of information fields on the app that would be useful.

METHODOLOGY

At this point, I developed two evaluation methods to determine whether I was working in the right direction: usability testing and distributed cognitive walkthroughs (DCWs).

Usability Testing

I conducted a basic usability test using think-aloud and observation techniques (Jacobsen, 1999). I recruited five adult students familiar with usability principles for this testing and assigned them each to two tasks: searching for free food on campus and posting surplus food. I chose this scenario because there are many events on campus with free food for attendees and a sort of culture of seeking out these opportunities is very common. It is also similar in concept to seeking food to glean and could be argued that this form of information seeking is gleaning. As the students were trained but not necessarily experts in usability principles such as Nielsen's (1994), I am fairly confident that a large majority of general usability problems were discovered.

The students then completed a System Usability Scale (SUS) questionnaire for a "quick and dirty" summative evaluation. The scores were calculated using the original method (Brooke, 1996) and compared to more practical measures for making sense of it (Bangor et al., 2009).

DIstributed Cognitive Walkthrough (DCW)

Methods like usability testing are apt for most computing evaluation scenarios, and the works cited often use such methods for single interfaces or in a controlled time and place. However, as this project has used primarily service-dominant logic in the design process, I wanted to evaluate my work in the same vein. As such, I decided to use the DCW (Eden, 2007; 2008) variant of the common cognitive walkthrough (CW) method (Wharton, 1994). I recruited five participants: two food bank sourcers, two dumpster divers, and one large-scale transporter.

This method starts with creating a hierarchical task analysis of participants gleaning methods. As I was trying to understand how this service may affect different aspects of their gleaning activities, I first tried to mentally situate them in their normal contexts by way of a brief deferred contextual interview (Mancini et al., 2009). Since Gleanhub does not accomplish a task that occurs in one time and place, it's important that participants consider all the actions undertaken by people before them, what they undertake, and

what information they pass on to others. For this reason, the DCW involves four questions for each task:

- Will the way that information is represented show relevant previous progress towards the overall task?
- Will the way that information is represented provide all knowledge required to carry out the task?
- Will the way that information is represented provide resources that relieve the user from having to figure out or calculate anything in his or her head while carrying out the task?
- If the current task is accomplished, will the way that information is represented be changed in a way so that the result of the task is accessible by the current or other users at a later time or a different place?

FINDINGS

My findings were very helpful in identifying key usability issues, situational and contextual considerations, and directions for deployment to each of the participants.

Usability Testing

From the think-aloud and observations, the most significant usability issues and errors encountered were the following:

- Keyboard covered up auto-suggest list
- Could not search by generic names, only particular place, e.g. “grocery store” vs “Publix at 123 Street”
- Top auto-suggestions were sometimes in a different state
- Overlapping markers on map were hard to click
- No cancel button for opportunities dialog
- Free response form fields prompts and yields less robust information

The SUS score was generally favorable with a mean of 68.5 and standard deviation of 7.20, indicating the interface was at least ok and at best good.

Distributed Cognitive Walkthrough (DCW)

The DCW yielded more contextual information from experts.

Food Bank Sourcers

The sourcers described their tasks with recovering prepared meals via their oldest running program, Atlanta’s Table. The process for them was to answer calls from sources

like catering companies who had surplus prepared foods, note the information down, and then go down a list of agencies in the source's area and call each one to see if they could take the food. The food may be frozen or room temperature at the time the source calls and only have a limited window to share the food. The sources gave examples of frozen meat and trays of green bean casserole, respectively. The sourcer then tries to get a local agency to pick up the food or arrange the source to drop it off, or the sourcers themselves try to arrange the food bank to handle transportation. This process though is often time consuming and the results are often dwarfed relative to the same amount of time securing many pallets of food from a large distributor.

Their initial reaction to Gleanhub was mixed. My intention for this service to be public was the main issue, as they said that if it were public, the food bank wouldn't get the credit for sourcing and distributing the food. Thus they would lose some status as a central figure in food security. The sourcers themselves would be affected by this, as there was significant pressure from the Feeding America network on the them to find new food streams. One sourcer said, "this kind of cuts us out."

Asking how they would perceive Gleanhub if it were something deployed by the food bank within their system, without all its functions being public, then that wouldn't be an issue at all since the food bank could then take credit for it and track statistics. Instead, they said they may be able to alert their agency partners (e.g. food pantries) more easily and reduce their workload. They suggested that when someone in their county or area posted that they have food, then agencies in their area should get a notification, first come first serve, but should be able to lay claim to reduce the chance of race conditions.

Finally, they said that in order to pass on important information, the interface should prompt posters to indicate whether they have a loading dock, what the condition of the food is, and the type and quantity of food. These were all related primarily to the shelf life of the food, which is significantly shorter if at room temperature rather than frozen, however, frozen food is also not ready to eat and thus not appropriate for immediate consumption. The interface should also provide at least the temperature and time since the post was made when searching for food. This way, prospective gleaners could decide whether it is worth to take the food compared to resources spent and intention for using it, while the other information would also be important to filter by secondarily.

Dumpster Divers

The two dumpster divers walked through their process similarly to the participant in the formative work, going into more detail about personal safety when at dumpsters and planning before that. One said, "as an efficient person, we pick places in our area, and we'd plan a route to take." They continued to describe how it is impossible to know the

content and condition of a dumpster before getting there, but it is important to know general things and would be helpful if a crowdsourced application could do initial legwork for keeping that updated.

One said that it could be similar to the mobile traffic and incident reporting application Waze, which allows users to crowdsource reports of incidents like collisions and broken traffic lights. They said they would like to “tag locations as good (or not), has food that we're not taking, whether the compactor is broken or fixed, or smelled bad.” One finding from the formative research is that it is generally understood that divers should not take more than they need and leave the remainder in a more accessible place for divers after them. They also said that they avoid smelly dumpsters and remarked about how the outside temperature can significantly affect that.

Another aspect of that they suggested would be to keep others updated or at least use the app for their own reference of their past excursions. They would want free-response fields to type when there is extra food for others to take, whether the owner of the dumpster is amenable to diving, and noting whether the people who dump food put gleanable items in separate bags. They said that bagel places sometimes bag their leftover bagels separately so that they can be gleaned more easily.

Large-Scale Transporter

The large scale transporter also echoed findings from formative research. They worked with an NGO in India aware of issues in how farmers take their food to and from market and how donations usually worked with different actors. The main concern for these transporters is whether it is too expensive to justify transporting product they can’t sell. Transportation in both this case and the U.S. is built on efficiency and drivers compensated or punished for it, but they are also aware of the potential for waste.

Before making the decision to donate food, they would first need to know how they can sell the product at any rate. Sometimes, they cannot and it is not worth it to try seeking a destination and dump the food into a local dumping grounds. If they do decide to donate the food, they need to know where to take it, what the start and end times for picking up or dropping off the food, and how to access the destination. Similar to the food bank, it’s important whether the source and destination have loading docks for the trucks to easily load or unload the items.

Truckers rely on quick communication in general, like the food bank, so having direct contact with gleaners is more important than the more non-confrontational dumpster divers. For example, like the food bank, it would be important for the transporters to receive some kind of notification that someone's coming to get the food so that they

don’t have to transport it themselves. Finally, they said that to pass the information on, it would be valuable to tag and comment on opportunities like the number of people that this food would feed (e.g. meals for 10 people) in order to communicate it in practical terms.

DISCUSSION

These results point to some clear improvements to the system in general, perhaps to Mobile-Map-IO as well. In all cases, there were many shared concerns and feature requests that seems to justify the decision to create an easily forkable boilerplate application for customization to individual contexts. Even the context-specific results are not outside the abilities of Gleanhub as it is now, with the usability testing results applied. Considering the amount of time it took to develop this application, it would take significantly less time to make an app specifically for a food bank, dumpster diving, or transportation. There are already existing solutions in these spaces: Choice (and AgencyExpress), dumpster diving online communities, and Food Cowboy, respectively. However these are all fairly closed systems that operate for profit. As such, their priority is in individual success and local need rather than the holistic view that this project suggests for future work.

FUTURE WORK

As the previous section discussed, there are clear areas of improvement and several avenues of more targeted user-centered design opportunities. The work presented in this paper describes how such a design intervention at the food system level could affect sociotechnical interactions. In addition to the results presented above, I present the following other areas of further research and development.

MOBILIZATION

The capacity and availability of actors to move food between them was one key issue in current gleaning activities, including the out-of-scope third design iteration. WIth the availability of a holistic design intervention by way of a hub for gleaning information, a peer-to-peer overlay network scheme for gleaning on top of food systems could solve networking issues. By raising awareness through more widely trusted channels, like social media and more direct forms of ICT, it may be possible for a hotter medium to educate and engage non-gleaners. For example, a service that suggests picking up food from a common gleaning source and moving to a common destination, both on or near a route they frequent, would both directly contribute to gleaning efforts as well as more comfortably introduce non-gleaners to the practice. This could be accomplished through integration of the Gleanhub web service with a service like Google Now. This interaction

would prompt people using it to decide when to start driving to avoid traffic to also add some time to their commute to move food between sources and destinations (Figure 7).

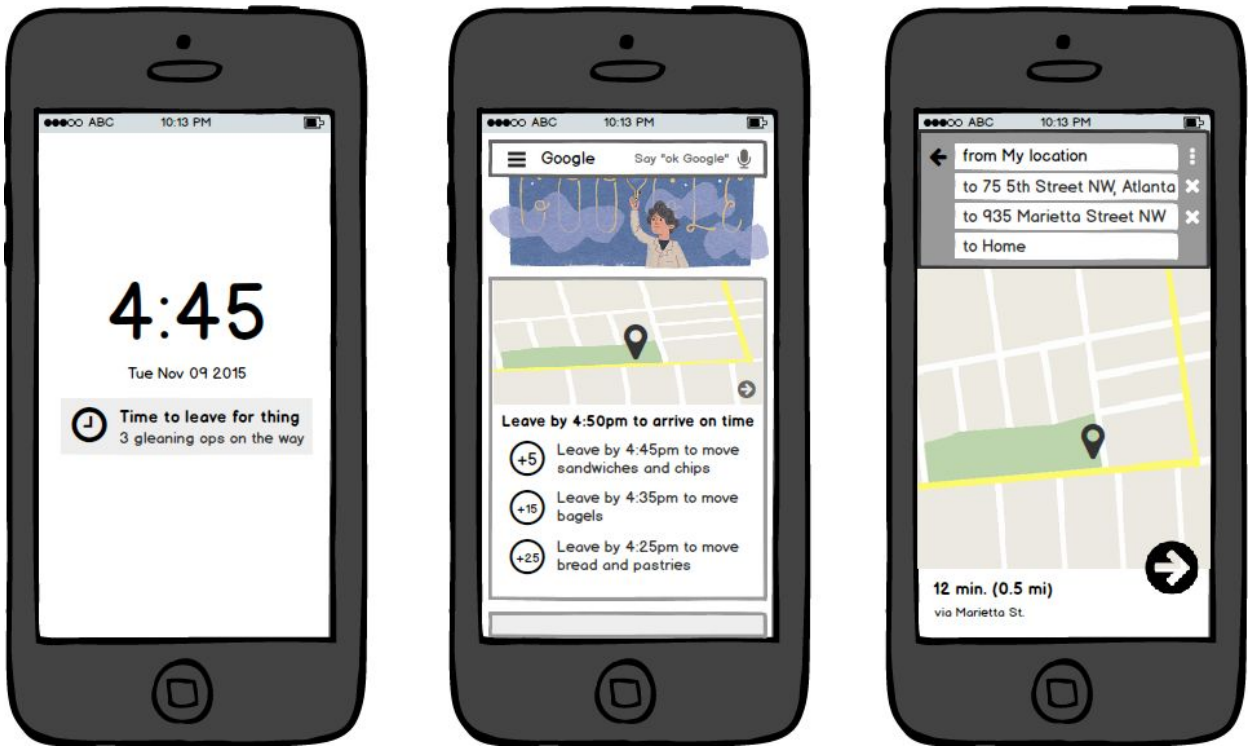

Figure 7: Mockup of Google Now integration with the Gleanhub web service

TRUST

After a critical amount, availability, and resolution of data, key stakeholders may buy into a data-driven mentality for existing civic systems. In the case that the Gleanhub web service provides significant data like this, it is possible that a city would make use of this data for making civic decisions. The City of Boston for example has an interactive budget that breaks down data by department, funding source, and intended projects to be funded. I have mocked up in Figure 8 what it might look like if surplus food traffic between civic entities like Atlanta's Neighborhood Planning Units (NPUs) were tracked instead of budgets.

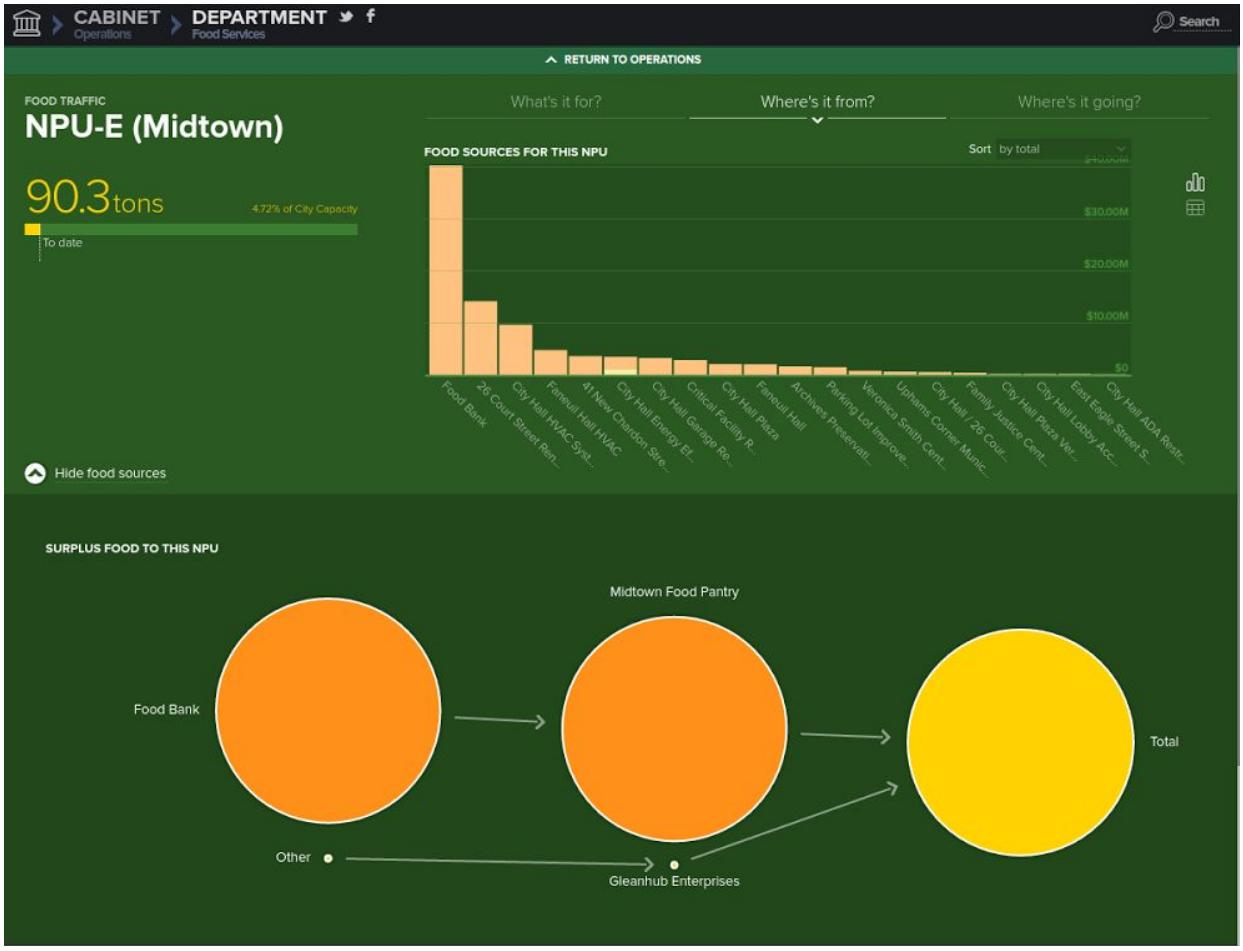

Figure 8: Mockup of a city's Food Traffic dashboard for tracking surplus food movement between entities

EDUCATION

Finally, with a wealth of data such as the previous case, especially if it is open, civic hackers may make use of these resources to create and discover new things. As I discussed previously, Gleanhub is a fairly simple localization of a set of common design patterns in mobile reporting, which I developed as Mobile-Map-IO. I intend to take it to the next Govathon (Atlanta's civic hackathon) to see what civic hackers can turn it into. I have continued to work with Ali from the Pakathon project to continue development of Mobile-Map-IO into a bribery reporting system called Rishwat. To date, there have been three contributors to the Github repository from Code for Atlanta meetups. By introducing a boilerplate application as being both easy to develop with and deploy and by showing examples of application like Gleanhub and Rishwat, then it would be interesting to take a civic hacktivist perspective of education on issues of food waste and food insecurity.

SUMMARY

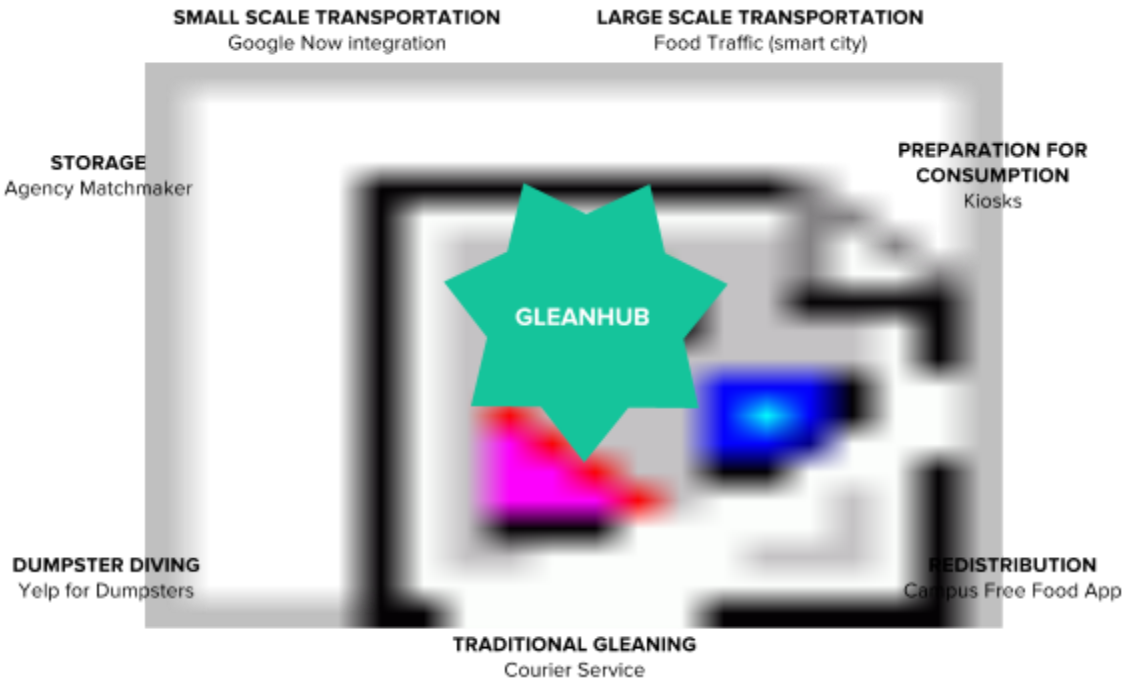

Figure 9: Areas for future work for each gleaning activity, as described in previous sections.

As I've covered so far, there is an API and networking service that can enable better internetworking between insular networks like FNB and the food bank. The service can be more practically enabling through the interfaces that I've evaluated, indicating many touchpoints are possible within for digital gleaning experiences. For example, they can be developed as a streetside kiosk, a sort of Yelp for dumpsters, a food bank agency matchmaker, a campus free food app, or as a sort of gleaning courier service. Now that the research and practical spaces are better understood and the technical requirements and actors defined, it's a much more straightforward matter of developing these individual touchpoints that I intend to continue developing.

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APPENDICES
Appendix A

Gleaning is an activity that involves many digital and nondigital tools and services. The following is a list of just the digital ones that have been studied for this survey.

Ample Harvest	information hub on gleaning, food salvage, community gardens, self-congratulation, and related data	http://ampleharvest.org/
Concrete Jungle map	aids concrete jungle efforts, also crowdsources its input as well as broadcasts public property foraging data	http://www.concrete-jungle.org/food-map
Cropmobster	a social network for many gleaning-related activities	http://sfbay.cropmobster.com/how-it-works/
#DonateNotDump	to tell grocery stores to donate to food rescue programs and let them know they are safe to do so; also this guy will provide legal assistance for dumpster diving cases	http://robgreenfield.tv/arrestedfordumpsterdiving/
Falling Fruit map	completely crowdsourced map for urban foraging and gleaning, also a data source for freegans	http://fallingfruit.org/
Feeding America	national food bank networking charity, food security advocate, researchers, information hub	http://www.feedingamerica.org/
Food Cowboy	lets food donors alert "approved" charities to tranport food where it can be used	http://foodcowboy.com/how_it_works_local/
Food Innovation Network	think tank / discussion group around social services involving food	http://www.civicatlanta.org/join-a-civic-network
forums, message boards	provides peer-to-peer information sharing, especially for dumpster diving	various
Fraser Valley Gleaners	picks up donated food and makes dehydrated soup mix out of it	http://www.fvgleaners.org/about
Freegan.info	provides information about freeganism, also hosts a directory of freegans' diving spots in some cities (mostly NYC)	http://freegan.info

Gleanhub (API, information)	connects actors with potentially wasted food to actors who could use the food	http://andyhub.com/portfolio/gleanhub
God's Little Acre farm	trades produce for harvesting and other volunteering, uses website to communicate that, relies on locals for most of the business	http://godslittleacrefarm.com/
Hosea Feed the Hungry & Homeless	"Assess, Investigate and then Connect" methodology	http://4hosea.org/page/about-us
I Value Food	site with tips on reducing food waste	http://ivaluefood.com/
Just Eat It	a movie about food waste and food rescue	http://www.foodwastemovie.com/
Leanpath	software and device that tracks food loss of a preparer/restaurant/etc	http://www.leanpath.com/
LeftoverSwap	helps users swap their leftovers	http://leftoverswap.com/
Literature & toolkits for guiding prospective gleaners/donors/volunteers	published by organizations like food banks and USDA, point people in the direction of other resources	various
Managed gleaning, like Hoisington et al. (2001)	professionally trained and supervised volunteers perform field gleaning practices	various
Nourish Now	collects surplus fresh food from partners, then redistributes to families in need and other county nonprofits that provide food assistance to those in need	http://nourishnow.org/about/
Panera Cares	like a pay-what-you-want food pantry, plus a volunteer-with-benefits job	http://paneracares.org/
PareUp	Retailers post unsold, unexpired food for a discount.	http://www.pareup.com/
Positive American Youth (P.A.Y.) USA	operates a food pantry	http://www.payusa.org/home/programs/#tab-7
relief/farm websites	websites of farms and relief organizations	various

"replate"	concept of putting wasted food on top of garbage bins instead of in it for easier recovery	http://www.replate.org/replate2.htm
Ripe Near Me	marketplace for produce, emphasis on free sharing but no requirements	http://www.ripenear.me/
Serve.gov	contextualizes lit & toolkits as a civic duty	http://serve.gov
Society of St Andrew (End Hunger)	they glean from farms, salvage from refused shipments, and distribute to food pantries	http://endhunger.org/
Still Tasty	comprehensive information about how long you can keep thousands of foods and beverages, has an iphone app	http://www.stilltasty.com/
Why Hunger? Network	a map of hunger-related organizations and gleaning ops	http://networks.whyhunger.org
WISErg	compost machine, fertilization service, and compost tracking app	https://wiserg.com/

Appendix B

↱ moves food to	Post-harvesting	Large-scale transportation	Preparation for consumption	Dumpster diving	Small-scale transportation	Food pantries
Post-harvesting	1		2		3	4
Large-scale transportation					5	
Preparation for consumption	6		7	8	9	10
Dumpster diving			11		12	
Small-scale transportation			13		14	15
Food pantries						

1. Concrete Jungle map; Falling Fruit map
2. Gleanhub; Cropmobster
3. Food Cowboy; Gleanhub; Cropmobster

4. Ample Harvest
5. Food Cowboy; Gleanhub; Cropmobster
6. WISErg
7. LeftoverSwap; PareUp; Gleanhub; Cropmobster
8. I Value Food
9. Food Cowboy; Gleanhub; Cropmobster
10. Ample Harvest
11. Gleanhub; Cropmobster
12. Gleanhub; Cropmobster
13. Gleanhub; Cropmobster
14. Food Cowboy; Gleanhub; Cropmobster
15. Why Hunger? Network; relief/farm websites Gleanhub; Cropmobster

Appendix C

↱ is engaged for	Getting attention	Post-harvesting	Large-scale transportation	Preparing for consumption	Dumpster diving	Small-scale transportation	Food pantries
Direct ICT	1				2	3	
Social media	4	5		6	7	8	9
Informational website/app	12	13		14		15	16
Educational events/apps	17	18		19			

1. Phone, email, SMS
2. Phone, email, SMS
3. Phone, email, SMS
4. PareUp; Cropmobster; Relief and farm websites; #DonateNotDump
5. Cropmobster
6. LeftoverSwap
7. PareUp; Gleanhub; forums
8. Why Hunger? Network; Food Cowboy
9. Why Hunger? Network; Food Cowboy
10. Relief/farm websites; #DonateNotDump; Facebook; Twitter
11. Facebook
12. Serve.gov; relief/farm websites; Concrete Jungle map; Falling Fruit map; Why Hunger? Network
13. Cropmobster
14. Still Tasty; I Value Food
15. Blogs; guides
16. Why Hunger? Network; Ample Harvest
17. Cropmobster
18. Cropmobster
19. Still Tasty; I Value Food; CropMobster

Appendix D

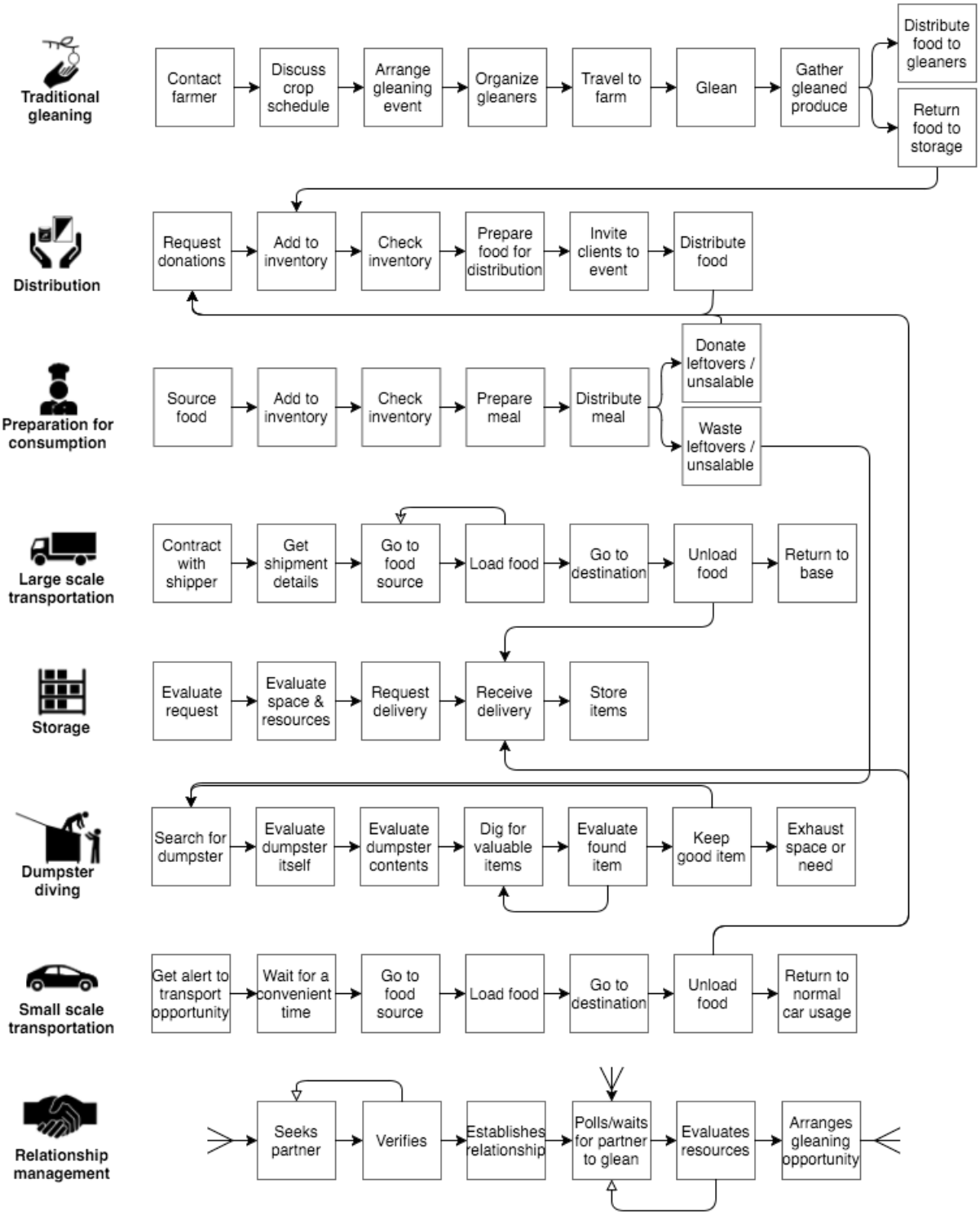
Iteration 1 presentation, including initial research, personas, scenarios, and low fidelity mockup of a kiosk and website for gleaning.

Appendix E

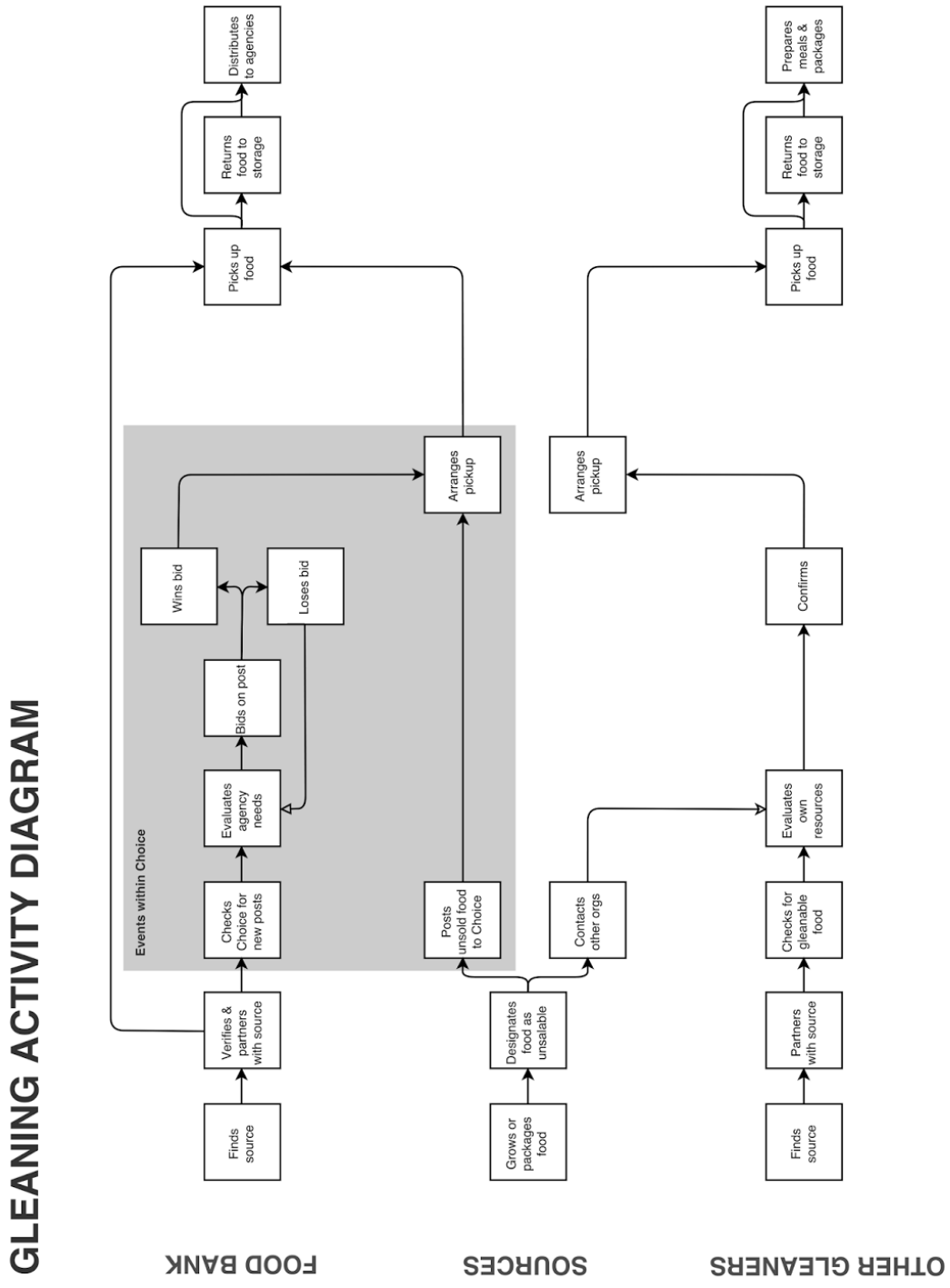
Iteration 1 presentation of a higher fidelity mockup from Appendix D.

Appendix F

A COMMON TASK SEQUENCE OF GLEANING ACTIVITIES



Appendix G


GLEANING ACTIVITY DIAGRAM
FOOD BANK
SOURCES
OTHER GLEANERS
Finds source
Verifies & partners with source
Checks Choice for new posts
Evaluates agency needs
Bids on post
Wins bid
Loses bid
Picks up food
Returns food to storage
Distributes to agencies
Events within Choice
Grows or packages food
Designates food as unsalable
Posts unsold food to Choice
Arranges pickup
Contacts other orgs
Arranges pickup
Finds source
Partners with source
Checks for gleanable food
Evaluates own resources
Confirms
Picks up food
Returns food to storage
Prepares meals & packages

Appendix H

The evaluation form used for usability testing and organizing some DCW notes

Appendix I

Data protected by IRB is kept on Georgia Tech's OneDrive folder shared to study personnel and not reproduced here. Please log in to access this data and manage per IRB protocol H15053.