From Checking On to Checking In: Designing for Low Socio-Economic Status Older Adults

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ABSTRACT
In this paper we describe the design evolution of a novel technology that collects and displays presence information to be used in the homes of older adults. The first two iterations, the Ambient Plant and Presence Clock, were designed for high socio-economic status (SES) older adults, whereas the Check-In Tree was designed for low SES older adults. We describe how feedback from older adult participants drove our design decisions, and give an in-depth account of how the Check-In Tree evolved from concept to a final design ready for in situ deployment.

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Aging in Place; Older Adults; Caregivers, Peer production.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The population of older adults around the world is growing faster than the number of people available to help provide care for them [5]. While previous research [e.g., 8-9,11] has investigated how technologies can be used to help older adults age-in-place, much of this research has been conducted with higher socio-economic status (SES) participants. In this paper, we focus on designing technologies specifically for low-SES older adults. We define low-SES as older adults whose household income is at or below 200% of the federal poverty line (for 2012 this was an annual income of $20,000 or less [4]). We focus on this special population for a variety of reasons including that the area is under-researched, members of this population typically report worse health status, have more limitations on their physical functioning, have poorer overall health outcomes and generally have fewer resources with which to deal with these limitations [1-2]. Thus, there is an opportunity for our designs to have significant impact.

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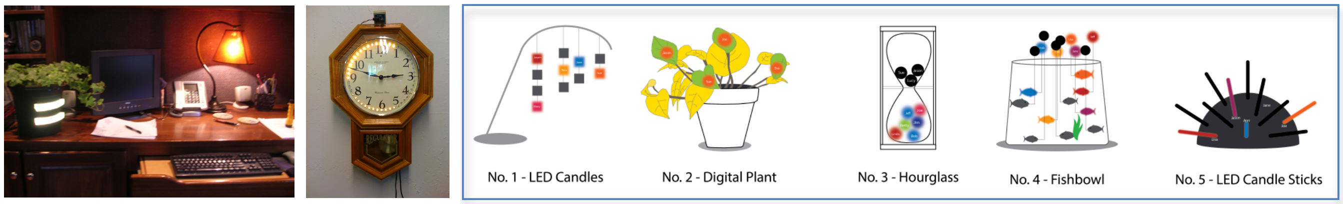
In this paper, we describe the design evolution of a remote sensing technology through three iterations, describing how each instantiation was adapted to meet the specific needs of the target population of rural and urban-dwelling low-SES older adults. The technologies we describe are part of a larger suite of tools designed for a single household installation, which includes an older adult-centered method for receiving short messages, a magnet board for easy data entry, and tools for privacy controls. The focus of this short paper is on two of the other technologies in this suite: the Presence Clock and the Check-in Tree.

CHECKING ON: AMBIENT PLANT & PRESENCE CLOCK
The ambient plant (Figure 1a) was designed to connect older adults to their remote caregivers while respecting the privacy of both parties. A set of paired plants allows each party to gauge the activity of the other (as detected by a motion sensor) on their local plant (as displayed by LEDs). One difference between this and other similar technologies (e.g., the digital family portrait [9]) is that activity monitoring is displayed reciprocally, meaning that a caregiver can see activity from the older adult and the older adult can see activity from the caregiver.

The ambient plant was tested in situ in one pair of homes with one older adult and one caregiver for 2 weeks, and was evaluated in a focus group study with 65 older adults in which participants interacted with a variety of prototypes in a living lab and provided feedback [8]. In general, participants described how they thought using the technology would help them feel more connected to a caregiver, and caregivers felt that they would feel comfortable that the older adult was active, and not in need of assistance. On the other hand, participants expressed concern with "missing" the other person's motion since the LED lights on the Ambient Plant were only shining when the paired plant sensed activity. This led us to the design decision that we needed to include some type of activity history in the display.

The Presence Clock (Figure 1b) extended the idea of sharing motion information between paired objects with a historical display. Each clock is made from an existing analog desk clock modified with a motion sensor mounted on top. The sensor transmits detected motion to its paired clock. Each clock had 48 yellow LEDs placed around the clock face with each LED corresponding to a single 15 minute interval, affording both an easy representation of



(a) (b) (c)

Figure 1: (a) Ambient Plant (b) Presence Clock (c) Check-in design ideas

current activity, as well as a historical account of motion detected over the last 12 hours.

Previous researchers evaluated the Presence Clock in the homes of 4 older adults and their informal caregivers as part of a larger study of a suite of technologies [12]. In these studies, the clock was well received by both older adults and their families. Comments were similar to comments about the Ambient Plant with respect to enhanced feelings of connection.

SOCIO-ECONOMIC STATUS

In our current research, we are focused on understanding how technologies can be designed to assist low SES older adults in both urban and rural settings. We conducted day long (i.e., eight hour) contextual observations in the homes of eight low-income, community-dwelling, older adults [13]. The contextual observations explored participants' physical environment (i.e., house, neighborhood and town), regular social interactions and daily routines. Unlike their higher-SES counterparts, the lower-SES older adults did not necessarily have a single informal caregiver.

Previous work in HCI [e.g., 6, 9] has focused on designing for higher-income older adults where technologies support a one-to-one (caregiver-to-older adult) relationship. In our work, similar to findings in work with another low-SES population (asthma patients [7]), we found that the low-SES older adults in our study had a much richer ecosystem of family members, service providers and peers who often served as informal caregivers.

The low-SES participants we observed relied heavily on their peer-group for a variety of needs, including socializing and running errands:

P1: "When I first moved in, the guy around the corner used to take me to stores and stuff like that, and cash my check. Every time I'm going to go to the grocery store I get him to go and take me."

However, these same participants also described how they were loathe to burden the traditional one-to-one informal caregiver: a family member. Participants described how individual family members were already struggling to take care of their families (including small children), and often multiple jobs. These findings suggest that we need to reconsider the model of care for which we design, from a one-to-one caregiver-to-older adult model to a peer-to-peer model in which older adults help care for each other.

The peer approach has many advantages. By replacing the individual caregiver with a peer group, each older adult has more eyes watching for them in case there is a problem. There is also less social stigma associated with asking about the day-to-day business of peers. This allows for less friction in terms of communication and may enhance activity within a community. Finally, strong peer groups are a strong motivation for older adults to be more active in their community, both physically and mentally, which can lead to a healthier lifestyle. This structure allows older adults to maintain their independence, which is a value that is highly important for older adults [11].

CHECKING-IN: CHECK-IN TREE

To generate ideas for a peer-based check-in system, we revisited findings from the contextual observations we conducted with low-SES older adults, spent time sifting through and categorizing designs from catalogs and stores that sell objects to older adults, and held weekly design sessions where we asked researchers to generate ideas. We also recruited a small group of older adult to serve as informal consultants [n=3].

We noted that older adults often devise a check-in system in which they can indicate to a neighbor that they have gotten up in the morning (e.g., turn on/off the porch light) and the neighbor agrees to call if they are not up by a certain time [10]. This system only works if someone nearby is willing and able. However we found that many low-SES older adults lack both a willing, co-located neighbor and reliable transportation, making it difficult to physically check-in on each other. In our designs we sought to remove some of these constraints and extended the idea of a morning check-in to utilize peers in a remote check-in prototype, allowing older adults who are not immediate neighbors to check on each other.

We developed five design ideas for a daily check-in display (Figure 1c) that show check-in information for a small group. Since we did not yet have information about the properties of the social groups of participants for these initial designs, we left some flexibility with respect to size of the group, but generally used 4 to 12 as our initial range of group sizes. From these five designs we brainstormed how we could build each one and do so at the scale required for our future field studies. Designs 2 – 4 (Figure 1c) proved to be very difficult to build since they involved parts with either complex movements (3 and 4) or simple

(a) (b) (c)

Figure 2: Three iterations of prototypes: (a) foam core, (b) tree without leaves, (c) final prototype.

movement but complex construction (2). We decided that an interesting grouping of non-moving lights that represent group members such as with designs 1 and 2 represented the best balance of building requirements and design constraints. At this point we began breadboarding the circuits, researching wireharness materials, working out costs, and developing an online control system for lights.

Check-In Tree

The final check-in prototype is a tree holding 8 picture frames (Figure 2c). Similar to the Ambient Plant, a tree may spark positive, healthy sentiments for the users. Trees are often used to represent families and to depict an individual's lineage. In our case, we use the tree to invoke the concept of a community and a sense of connection to peers. This tree design proved to be most well liked by our design team and had a straight- forward implementation.

In the final design, older adults have their own Check-In Tree, with a picture of everyone in their peer group, including themselves, hanging on a branch. Each picture has its own LED. In the early hours of the morning, all LEDs start to pulse gently. When an older adult gets up for the day, they press a button at the base of the tree to indicate that they are up (i.e. "checking-in"), causing the LED associated with their picture to switch from pulsing to on. This change is propagated to all of the trees in the group. In this way, an older adult simply needs to glance at their Check-In Tree to tell whose LED is still pulsing, and thus know who has not checked in that day. Having the LEDs pulse when someone has not checked in draws attention to those older adults who need to be checked on in person or by phone. The Check-In Tree empowers older adults to use and develop their knowledge of each other's daily routines and special circumstances, reducing unnecessary stress caused by false alarms in alert systems.

Finally, the Check-In Tree also has a switch for older adults to indicate when they will not be home for extended periods. When an older adult turns the switch off, the LEDs associated with their picture will turn off on all of the connected trees. In addition, all of the LEDs on the Check-In Tree in their home will also turn off, so they are incentivized to keep their trees on when they are home.

Evolution of Tree Form

Unlike other research (e.g., [14]) that focuses primarily on the aesthetic of a user's home and the relationship between the user and their possessions, we built several prototypes that allowed us to investigate functionality, aesthetics, cost, and a simplified construction process.

(a) (b) (c)

Figure 3: Three types of trees: (a) Oak, (b) Willow, (c) Juniper

The first prototype (Figure 2a) was a foam board construction of two tree types and two photo frame designs. Several challenges arose, including that the branches needed to hold picture frames. We developed a design that would allow frames to hang from branches and supply power, ground, and two data wires to each LED module. Foam board allowed us to evaluate affects of different branch layouts on the position of electronics and tree frames. It also gave us a sense of scale and size.

The second prototype was a 20" wide tree cut from 5/8" plywood (Figure 2b). This frame had several benefits: it could easily house the wires to power the LEDs; the thickness of the wood made hanging tree frames easy; grooves for LEDs controlled the direction of the lights; and the channels designed to hold wires made for an easy template to measure wires and solder them to their LEDs.

At this point, we further explored the aesthetics of the prototype by constructing three different types of trees (Figure 3): an oak, a willow, and a juniper. The picture frames were made with acrylic glass with an etched border to diffuse the light from the LED. For the frame border, we selected one simple design based on the ability of our CNC router to cleanly etch the pattern. We also explored the placing of the frames on the tree, hanging them below the branches like fruit.

Based on feedback within our research group and from our older adult consultants, the oak tree was selected as the final design. At this point in the design process, there were many fine-tuning details considered to make the tree look more aesthetically pleasing to the user and to finalize the functionality. The base was designed with the button and switch for easy user interaction. There were several iterations of LED placement, frame placement, and shape of leaves. Originally, the oak tree had a few tiny leaves and was overall very bare. One older adult consultant worried the points of the branches posed a safety issue; therefore, the leaf clumps were added to address safety issues and improve aesthetics. We sought to meet the aesthetic desires of older adults, identify ways to attach personal meaning (as suggested by [6]) to the devices, and increase the possibility that the technology would help participants achieve greater independence with each iteration. Finally, a back covering was added to hide the wire harness.

DISCUSSION

All three prototypes (Ambient Plant, Presence Clock and Check-In Tree) were created with a user-centered design process and tailored to the needs and desires of the target populations while fitting within a tight budget and short schedule for construction. Our research showed that reciprocity was greatly valued in these prototypes, and we sought to preserve that in the peer-based technology.

The nature of the shared data in the Presence Clock (i.e. real-time and historic presence) was less appropriate for a low SES population because they were unlikely to have a single informal caregiver. Instead, our participants relied more on peer support, which radically changed our design.

One design choice was to have each older adult's Check-In Tree include their own picture. Prior research suggested that older adults often liked to look and see what others could see about them [3]. The Presence Clock had this capability through a special tablet interface. The Check-In Tree includes this functionality within the prototype itself.

Once design choice of particular importance was to make the daily check-in a manual input (push the button), instead of an automatic one. We hope that by incorporating an interaction with the tree as part of their daily routine, older adults will feel more connected to their peers. However, this extra burden may reduce use of the tree, particularly for those older adults who have limited mobility. We have designed the tree such that the button interaction can easily be replaced with a motion sensor to automatically "check-in" an older adult if we find use is low or burdensome.

Another important design decision related to mobility was to design all three prototypes to blend in to a home's décor so that older adults will place them in commonly occupied spaces, such as a living room. This will encourage older adults to view and interact with these prototypes on a regular basis, even as their mobility declines.

Finally, the tree was designed with cost, ease of construction, and reusability/adaptability in mind. We are currently building 18 trees to be used for this research and as a platform for testing other ideas. The wooden tree can be filled with different circuits and different LEDs quite easily. It can be repainted and there is plenty of space for adding more ornamentation. It can be reprogrammed and adapted to further fit the needs of different user populations.

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