

Re-thinking Building Interface Characteristics in Senior Living Facilities: Equity and Energy

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ABSTRACT

Life has changed significantly since the silent and baby boomer generations were born. Buildings are becoming highly advanced with building controls and automation. These controls can be helpful in some cases, such as energy savings, and even in some instances to increase safety for seniors. However, often, controls and building interfaces are not well thought out, and some people are losing their ability to control their interior environments or forgetting how to altogether. Due to these advances in controls, people and younger generations use buildings differently; people formerly relied on passive or adaptive comfort strategies to manage interior environments: e.g., opening windows, changing clothing, and using their physical building interfaces to improve their spaces – these simple behaviors to maintain comfort, increase well-being, and save energy are becoming a lost art. To learn from these generations, such as how they lived in buildings, what strategies they used to make themselves more comfortable in the absence of technology, as well as how buildings have changed to automate the occupant out of the equation, we sought to capture stories of seniors' experiences. This pilot study implemented qualitative and narrative methods to interview and observe older adults in senior living facilities to better understand how the passing of time has changed their relationship and interactions within the built environment. This qualitative approach has garnered incredibly meaningful stories, lessons learned, and more, that will inform future senior living developments in the future.

Introduction

In 2017, individuals over the age of 65 consisted of nearly 15% (47.8 million people) of the United States population, growing by 1.6 million from the year prior (U.S.Census 2017). The population of Americans over the age of 65 is expected to nearly double by 2060 to 95 million, increasing their share of the American population from 16% to 23% (Mather, Jacobsen, and Pollard 2015). Nearly 40% of seniors over the age of 65 have at least one disability or have difficulty in general movements, such as walking, and seek individualized care options as their conditions progress (He and Larsen 2014; U.S.Census 2017). The concept of senior living is relatively new; when Medicare and Medicaid were enacted in 1965, elderly housing was primarily considered institutionalized care. As the Baby-Boomer generation ages, the senior care industry faces the challenge of meeting the needs and sheer number of incoming seniors in need of care in the future, as the oldest of this generation are beginning to consider senior living as an option for end-of-life care (Anderzhon 2012). With progress in legislation and industry investment, there has been a shift toward effective and inclusive care options (Wilson 2007). Seniors who need additional care may live in assisted care communities because they report needing assistance with more than one daily activity or Activity of Daily Life (ADL), sometimes

as result from injury but more often product of a combination of health-related concerns. Many seniors who are moving to these communities face big changes, including how they live in, operate, and control their personal spaces.

Life within the built environment has changed significantly since the silent and baby boomer generations were born (as early as the 1920's and as late as the 1960's). Buildings are becoming highly advanced with new control types and automation, which can be helpful in some cases, such as saving energy, increasing safety, and helping seniors maintain comfort. However, controls and building interfaces often do not consider the user experience of those with mobility or cognitive impairments, and some occupants are losing their ability to control their indoor environments, or even forgetting how to altogether (Lee et al. 2021).

Due to these advances in controls, buildings are typically designed and operated differently. For example, people formerly relied on passive or adaptive comfort strategies to manage interior environments: e.g., opening windows, changing clothing, and using their physical building interfaces to improve their spaces. These simple behaviors to maintain comfort, increase well-being, and save energy are sometimes abandoned through the automation of buildings and controls, and are often discouraged, as to not disrupt the sensitive building control environment. Older adults may have grown up in an age where these passive strategies were their only mechanism to achieve comfort, as central heating and cooling or modern lighting were not common or available.

Building occupant behaviors play a significant role in the energy use and comfort within a building, especially in multifamily housing situations like senior living communities (Maruejols and Young 2011; Ritter 2012; Yu et al. 2011). Conflicts between the passive strategies of managing comfort older adults are familiar with (e.g., simply opening a window) and/or highly automated buildings, poor design, and unfamiliar interfaces (e.g., digital thermostats, etc.) may result in wasted energy or resources as seniors navigate these controls.

The global growth of urbanization affects society in many ways, often prevalent through the appearance of new challenges to human health and well-being. As expected, the most affected are vulnerable populations, such as children and the elderly (Kabisch, van den Bosch, and Laforzezza 2017). Although the population of the elderly is increasing, their needs are still often underrepresented in building design and programming (Fatima et al. 2020). Their ability to walk and lead an active lifestyle, also affecting social life, depends on a range of factors in physical and cognitive health. Recognition and consideration of visual comfort is crucial in designing healthy environments for the elderly, especially since residents in long-term care often suffer from symptoms of circadian disruption including depression, difficulty sleeping, frequent daytime napping, and loss of cognitive ability (White, Ancoli-Israel, and Wilson 2013). Regular patterns of light can help to mitigate these symptoms, although it has been found that nearly half of the senior population often keeps blinds closed to avoid glare, and they often remain closed due to the inconvenience to reopen them (Kim, Chang, and Margrett 2021).

Window opening and clothing adjustment proved to be the first strategies older adults adopt, before they resort to an energy consuming strategy (Giamalaki and Kolokotsa 2019). This is often because of the difficulty of interface operability, whether that be windows, temperature controls, or even kitchen appliances. For the elderly, having a relationship to the built environment can impact their health (Takano, Nakamura, and Watanabe 2002; Wright and Lund 2000), emotional well-being (Beute 2014; Velarde, Fry, and Tveit 2007), and longevity, and despite other inequalities affect their relationship with natural spaces as it can be difficult to provide accessible green space for seniors (Bratman et al. 2019; Mitchell and Popham 2008;

Hartig 2008). To find the balance between improving comfort and reducing energy consumption, interfaces need to be intuitive and functional, especially for the senior population. One study concluded that inundating people with over-complicated and unnecessary features only hurts their health, comfort, and ability to save energy in buildings, and that designers must think about the passive, active, and interface features as one system together, rather than as separate concepts (Bordass, Bromley, and Leaman 1993).

Supporting our senior population is an individual choice, but it is pivotal in sustaining the rest of the population as well. Donnelly (2020) states “*Discrimination of care based on age is immoral and unethical, even when unintentionally not providing environments to help a group flourish. Ethics requires that moral agents act to prevent preventable harms, that we recognize the equal worth of all members of society and that we take special care of the most vulnerable among us.*” As a country and society, we must support the needs of older adults, and provide healthy, equitable, and safe communities for them as they age.

This project is the pilot study for a larger international study under *Subtask 1: Multi-aspect environmental exposure, building interfaces, and human behaviour* in the *International Energy Agency (IEA) Energy in Buildings and Communities (EBC) Programme's Annex 79: Occupant-Centric Building Design and Operation*. This paper represents preliminary results from the pilot study, and international results from the entire study will be presented elsewhere. This paper presents findings of a small-scale qualitative study of residents in nine senior living communities in the greater Seattle, WA area to better understand the way that older adults use their buildings, adapt to changing thermal, visual, and environmental stimuli, and their perceptions of building interface usability. While senior living is a rapidly growing industry, much has changed in the architecture and design world that may hinder occupants' abilities to manage their comfort in their own home.

Methodology and Approach

This qualitative research study employed one-on-one interviews, focus groups, and tours of senior residential facilities and private apartments to better understand human-building interactions, what is (and is not) working for older adults in these residential communities, and to seek opportunities for immediate and long-term improvement for the senior living industry. The following research questions guided this research paper, which are further discussed below:

RQ1. How do older adults interact with their buildings? Why?

RQ2. How do older adults manage their comfort in buildings?

Participants

Nine senior living communities, ranging across types and sizes, were visited to investigate the ways that built environments shape building interactions. Communities were recruited from existing relationships and contacted via email or phone to confirm availability and ability to support this research activity. In total there were 40 individual interviews and 5 focus groups, ranging in number of participants per focus group (2-10 people).

Participants in this study were residents of living communities for older adults, were over the age of 65, and were cognitively able to answer questions and understand the consent process. The researchers directly communicated with and sought participants from the recommendation or suggestion of living community staff and used a purposeful recruitment method to ensure that participants are cognitively sound and willing to sit for the duration of the interview. The

researchers considered the effects of cognitive decline in older adults in participation of this study, and as such, excluded participants who may not be able to recall stories as accurately as they occurred or those who might become upset, agitated, or confused through the interview or focus group procedure.

Based on the information provided, oral and/or written consent was collected from participants at the point of interview and participants had the opportunity to ask any questions regarding their involvement in the study at the beginning of the discussion. Participants were notified at the beginning of each interview that they had the liberty of answering or not answering the questions as they were asked, at any time. In general, participants of this study have experienced living in many types of buildings and eagerly shared stories of how their buildings (and human-building interactions) have shaped their lifestyle choices, personal comfort, and overall wellness.

Data Collection

Research data were collected through interviews and focus groups with adults over the age of 65 in their living communities. A semi-structured interview approach was used (Bernard 1988), which allowed the team to collect specific data while providing flexibility to explore issues about themes as the participant raised them, and these conversations were pursued in a person-by-person basis. The semi-structured interview prompts further allowed structured follow-up of discussion points when needed. Depending on the community and their in-person interactions policies due to the COVID-19 pandemic, interviews were held in person in either a secluded area of the participants community center or within the participants private residence. Interviews were audio recorded for transcription, and information was written physically on interview companion documents and transcribed for use in data analysis. This companion document helped the researcher collect information on participant demographics, notes from the interview conversation, as well as researcher observations about participant physical and cognitive wellbeing at the point of interview. Other notes included interviewer thoughts and comments on the participant statements, such as their feelings when telling certain stories or sorting their comments to relevant research prompts.

Data Cleaning

After data was collected, companion documents were scanned and data were transcribed, participants identities were removed and coded to unique identifiers. Interview audio recordings were transcribed using an automatic transcription service, cleaned for speech accuracy, and then paired to match the unique identifiers of the participants' interview documentation files. After transcription and data compilation, all data were further cleaned to remove incomplete or unclear responses. Additional data collected included interviewer notes and observations, photographs of communal spaces, floor plans, building interface photographs, and notes about features of the communities, which were then cleaned, organized, and sorted by category and building location. After data cleaning, researchers analyzed and coded the data holistically to identify themes.

Data Analysis

The Kawakita (1982) and Haskins Lisle et al. (2020) affinity diagramming method (or the KJ method) was used to establish primary themes and codes from the data. To increase validity

and reliability, three different researchers used the same three sample transcripts from the data to independently assess and annotate potential codes that emerged. The researchers organized codes and notes with an online concept board using digital sticky notes and sectioned subject areas, resulting in a diagrammatic model to base the following steps of coding. See Figure 1.

After key codes were determined, the data were analyzed in QRS Nvivo software using the Saldana (2016) method of iterative qualitative coding to deduce emergent themes and concepts from the data. Structured code groups based on key concepts such as community details (ex. address, neighborhood culture and size, local and on-site amenities), participant demographics (ex. age, race, birthplace, career, cultural identity), comfort (thermal, visual, acoustic, IEQ), safety (physical, perceived), technology (ex. building interfaces, mobile technology, computers, overall comfort with modern technologies, etc.) , nature and environmental preferences, and lifestyle choices were created and populated as interview responses were reviewed and sorted. These key concepts allowed researchers to further develop sub-codes, detailing further specificity underneath them. From this process, researchers were able to establish primary codes, which were further expanded upon during subsequent rounds of coding with the remaining transcripts, companion documents, and other collected materials. Coders of the data set each completed multiple rounds of coding, searching for relevant quotes, themes, and concepts, checking with each other to validate code assignments and definitions frequently. Once codes were assigned and sorted, relationships could be further investigated.

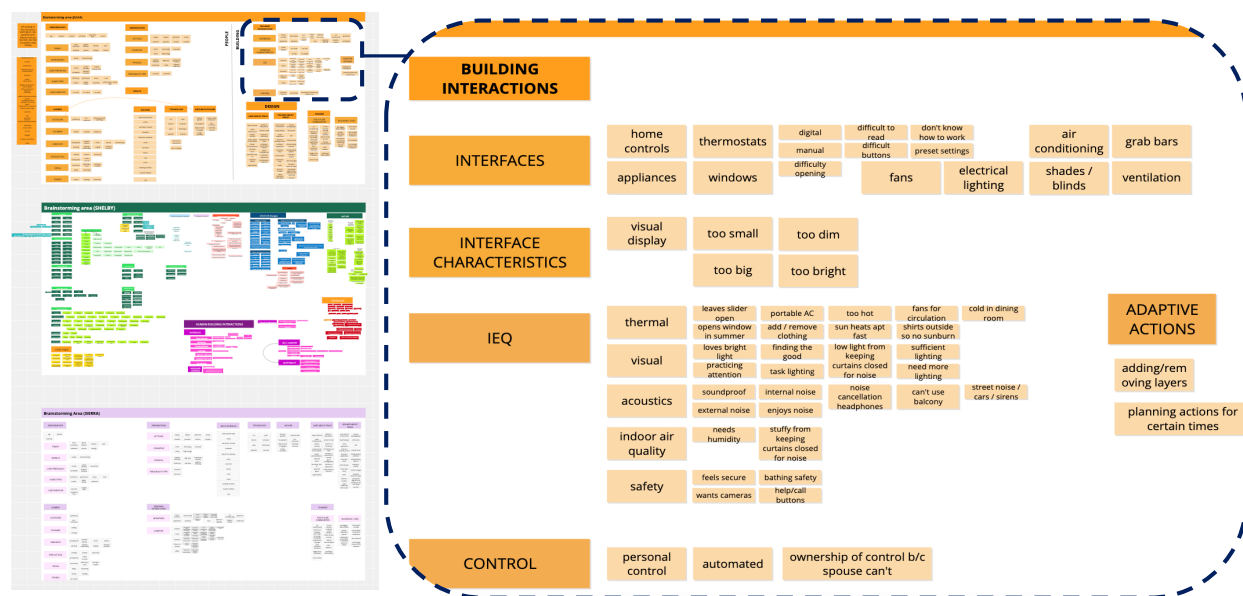


Figure 1: Concept board/digital sticky notes of emergent themes from the interview analysis, with coding example.

Research Limitations

As with any research project, there were limitations. The interviews were conducted with purposefully selected participants under the guidance of each community's staff and executive directors (as opposed to randomly selected), which may have influenced the likelihood of positive appraisals/reflections about their community and supporting employees, community features, and their understanding of community operations. Additionally, many participants were active members of their community's residence council, meaning they were likely more engaged

in the community culture than other typical residents. Residents' perspectives are shaped by many factors including, but not limited to, personality, education, earlier life experiences, their engagement in their community, their living situation, and culture. Another limitation of this study is that interviews were conducted within the Pacific Northwest. Therefore, the data collected is not representative of senior living in the broader region, state, nation, or worldwide.

Results

This rich dataset resulted in a plethora of outcomes and findings, ranging from concerns and impacts of the COVID-19 pandemic, senior safety and accessibility, occupant comfort, availability of nature, technology, and commentary about community features. However, this paper will primarily focus on the following key emergent themes (i.e., the primary themes that emerge from the data after reading, sorting, and re-reading participant responses): *comfort, interface characteristics, energy behaviors, access to nature, safety, energy, and equity*. The results are first organized by research questions and then further expanded through discussion, respectively.

RQ1. How do older adults interact with their buildings? Why?

Many of the older adults interviewed tended to use their private residences as a respite from the busy communal areas of their senior living communities. They often used their living spaces for rest, productivity, relaxation, entertainment, and for socialization, the latter particularly before the COVID-19 pandemic. They interacted with their kitchens, bathrooms, and living quarters throughout the day, for assorted reasons. For those who frequently cooked, interacting with the microwave, oven, sink, and cabinets were necessary for in-home meal prep.

Residents visited public spaces to interact with their neighbors, peers, and community staff for dining, socialization, and leisure type activities. Many participants noted their attendance of community programmed activities such as playing cards, attending movies or lectures, and community meetings. These social and public activities were typically held in prearranged areas of the building(s), where residents or staff would alter seating, temperature, or lighting for occupant comfort.

Occupants would open their windows and doors for ventilation, some use their thermostat controls frequently to change interior temperatures, adjust blinds or curtains for privacy and/or lighting control, as well as interact with their lighting wall stations to control the ambient lighting of their private spaces. Some residents relied on what they had learned in prior homes and altered their behaviors in specific ways to stay comfortable: for example, *"So what I do is I put a 20 inch box fan in the window, exhausting from one bedroom and open all the windows in the other bedroom and the other bedroom. And I draw through the apartment."* - ICB_01.

"OK, it's an old building. I get that the windows are hard to open. You got old people that aren't very strong anymore and we can't open our own windows so that over time get cracking that window. Earlier, though, something should be done about having windows that are easy to open, whether it be, you know, fixing the windows or adding a handle, you know, like everyday conveniences, like being able to open the windows and read your report." - MGTRU_03

In some cases, it appears that occupants could not behave in the ways they desired, either because a building interface (e.g. thermostat, window, etc.) or the built environment was unavailable or usable based on seeing, hearing, or physical impairments. While many of the conversations and details about daily activities were expected, we found that the built

environment did not necessarily support these daily activities adequately. In particular, some of the interfaces (e.g., thermostats) did not equitably serve this elder population due to smaller numbers, low contrast, and overall lack of understanding. This topic and specific findings surrounding interactions and special considerations are further discussed below.

RQ2. How do older adults manage their comfort in buildings?

One key finding of this study revolved around the many ways that older adults managed their comfort in their residences. Many participants voiced concerns over thermal and visual dis/comfort, as well as air quality, all of which became popular themes throughout the dataset. The following section explores some of the primary issues that arose, as they pertain to comfort, behaviors, and more.

Thermal Comfort. One of the primary topics that emerged from the interviews surrounded thermal comfort. The results and representative stories are grouped into three primary sub-codes or themes of thermal comfort: (1) adaptive thermal comfort, (2) thermostats, and (3) climate change, thermal conditions, and safety.

Adaptive thermal comfort. Some residents grew up in an age where central heating and cooling were not common and were well versed in adaptive comfort (adding/removing clothing, changing activities, etc.) and passive strategies (opening a window, shutting the blinds) to keep themselves comfortable in their residences. Many participants cited that it was far easier to change their clothing than bother with their thermostats, which was not surprising. While one individual noted that they chose to adjust their thermostat so they could open the window for fresh air. Many choose to crack windows when accessible, or even leave their door connected to the main hallway open, despite requests from staff for safety precautions. Overall, a wide range of thermal behaviors were noted.

- “Oh, yeah, if I get cold, I put on a sweater. If I get warm, I take it off. I usually dress in multiple layers... That’s the easiest way to control your environment.” - LKS_04
- “I take the temperature down to sixty-eight at night and I open the window because I love the fresh air. And then in the morning I take it up to 70 and it stays there all day. Sometimes I put it up a little if I’m feeling chilly. OK, but you know, it’s not a perfect system. It’s a little slow to respond but it’s better than not having it” - ALJMI_01

The ability to open a window in some of the targeted communities was inaccessible, restricting residents from fresh air, due to either heavy frames or inconvenient placement of window interfaces/locks. Many participants reported the need or want to use windows for fresh air, for refreshing stuffy air (i.e. movement of air), or to get cooler air when temperatures rise above comfortable levels indoors. This is especially a concern during the recent heatwave, when hot stuffy apartments posed a significant health risk to residents.

Overall, people were much more comfortable adapting to their environment using clothing or opening a window (when they were able to), than they were tinkering with a thermostat that was unreliable or difficult to understand. Some attributed this ability to the way they were raised, concerns about energy use, and/or for simplicity’s sake.

Thermostats. In other instances, there were residents, typically younger (ranging from their late 60s or early 70s), that relied solely on their comfort interfaces, like a thermostat or heater, to make their environment as comfortable as they needed, choosing not to change behaviors or clothing levels, as they were more familiar with climate control systems and expected them to work as programmed. However, many participants also commented on the unreliable and inconsistent thermostat controls in their private residences. We observed that there

were some instances where (a) the thermostats were actually unreliable and inconsistent (e.g., for the electric heating in some of the older facilities, many thermostats were fairly unpredictable or did not heat the space according to what was displayed) and/or (b) the residents *believed* the thermostats were unreliable because they did not respond how they assumed or wished they would (e.g., frustrated residents would get up from the couch to turn the thermostat up/down and the system was not responding fast enough, so they would keep doing it over and over until the conditions were so extreme that they would be uncomfortable). Manual thermostats were cited as far less reliable, but people seemingly understood how to operate them. Digital controlled thermostats provided higher reliability but posed challenges with the accessibility (visual and manual buttons), noises made by the controller (ticking or a clicking noise while turning on/off), and general confusion surrounding how to use them as intended. Other participants lamented about the small screens, buttons, and otherwise challenging interface controls. Additionally, non-backlit displays were consistently difficult for this demographic to use (see Fig. 2), especially those with poor vision or without appropriately lit apartments.



Figure 2: Differences in two digital thermostats in two different communities.

Some of the most common complaints included thermostats not being programmable and only having up/down temperature controls. Others noted that contrast or having the thermostat backlit was critical as well as the preference for large numbers and more information and more intuitive-ness.

“One of the most challenging to it in this this is not only in my apartment is our thermostat, you know, control of the thermostat. The thermostat is designed so that people can’t read it or understand it. Why new residents just get so frustrated. It took me a year, to finally figure it out. We’ve had previous engineers or maintenance men here who agreed that it was a poor design and in order to see the temperature, it’s this microscopic dot and I have to hold it down so I can see really. Right. But I have to use a magnifying glass and a flashlight to see this little green dot going up and down.” - MGU_02

Those most frustrated with thermal controls were not sure if they worked or how they worked, never understanding why or when it would start heating or cooling based on their temperature setpoints. With lack of instructions or a manual on using and programming their temperature control interfaces, many were left to their own devices of asking neighbors or family for how to use their thermostats. Additional thermostat types found across all study buildings are shown in Figure 3.



Figure 3: Thermostat types across senior living facilities.

Climate change, thermal conditions, and safety. The 2021 PNW heat wave was a scary time for many residents without air conditioning or knowledge about how to keep themselves cool. Many resorted to installing small air conditioning units (a behavior that was necessary for comfort, but not ideal for energy use), loitering in public conditioned areas in the community, or leaving the premises all together to escape the discomfort at family residences or cooling centers.

"I stayed with a friend, which is fine, but it's going to be this way now. So they're going to need air conditioning. So I know retrofitting is expensive, right. But everybody buying their own individual air conditioners and running them all day is more expensive. Long term, it's not sustainable. So I think they have to start looking into, you know, places like this that have been fine, that aren't going to be fine anymore." -MGTRU_03

Further, many participants asked for community guidance for how to keep themselves comfortable and safe during extraordinarily hot conditions such as this heat wave, as they felt they were left to their own devices during that time. Many felt helpless, hot, and unsafe. One resident made a particularly relevant and observant comment surrounding climate change and building design, as cited below.

"And I don't know what all buildings are going to do, but clearly we're living in a time of climate change and it's going to be hotter. And I had to leave here for a week when I got hot because my room was one hundred and ten degrees." - MGTRU_03

One of the most memorable events found through this research was shared by several residents. A story was shared about a fire door closing on a resident during this same 2021 heat wave. This event is not necessarily related to thermal comfort, however, the extreme heat wave led to a power outage, impacting other building interfaces and systems. While the resident was on their way to do laundry, the heat-related power outage triggered the automatic fire doors to quickly shut, and the heavy door hit the resident, resulting in their injury, decline, and ultimately death. While many fire safety codes and regulations require such features, consideration of

loitering zones and emergency support in such situations must be considered by individual communities for these infrequent but potentially dangerous circumstances. These unexpected consequences of building design must be considered for ultimate user safety.

Many of the stories shared directly related to thermal comfort, but there were also significant findings related to visual comfort; these are discussed in the next section.

Visual Comfort. Selected results and representative stories are grouped into three primary sub-codes or themes of visual comfort: (1) lighting conditions, (2) visual needs, and (3) access to views and nature.

Lighting conditions. In general, the seniors who were interviewed requested more lighting, specifically in closets, cupboards, and smaller spaces. Under cabinet lighting and in-drawer/cupboard lighting would help those with low visibility, as would safety lighting or lighting in the wall trim. Color tuned lighting options could help circadian function, as several participants commented on the intensity of the fluorescent bathroom lighting and going to the restroom at night in the dark as to not awaken themselves suddenly. Other instances cite poor placement of overhead lighting in unnecessary areas. Overall, the consensus that thoughtful placement of light, and more of it, would help most cases.

"Yeah. I'm not thrilled with the lighting in my living room, quite frankly... But it's hard to get to. I've you know, I have a lot of lights because I need good lighting to read. And just to see, in general, I don't like it to be dark. In the kitchen, it's fluorescent, which I've never liked. Yeah, I've always found that hard, you know, even in an office or what have you. Harder on the eye." - MGK_02

Visual needs. In addition to the need for more lighting, there were also other design issues that emerged through conversation that pointed to the need for thoughtful design for this particular age demographic. Many of the complaints, specifically around visual comfort, were about glare, contrast (or lack thereof) and materials. For instance, one resident said that due to their declining eyesight, the pattern on their kitchen countertop made it especially difficult to see anything on the counter, and they would lose items. Decline in eyesight was a common theme.

"But what I'm finding now as this eyesight problem has just really blown up lately, I I'm having a terrible time dealing with my kitchen because I can't see and I can't seem to clean. I can't see in behind and so forth and the lighting and so forth in the in the kitchen. But the problem is simply because of my blindness. And I do know there are a lot of people here in our age group that lose eyesight. And so I think the I my recommendation would be that those kitchens be done not in black, but in white. And I was looking at even more light colored tile floor in my bathroom. But the regular old fashioned tile wood and a light color would be much better than many lovely granite or whatever it is that's in there." - ALJMI_03

Access to views and nature. Another major theme that emerged surrounded access to nature and views. Specifically, having access to a view of lawns, trees, flowers, birds, bugs, mountains, and more reminded residents of the natural life outside of their building's walls. These elements of nature were connected to artistic appreciation or nostalgia and brought a sense of peace to many. Others deeply wanted this connection with nature but felt restricted from enjoying it due to concerns of sun exposure, safety while navigating the outdoors, or privacy in their residences.

- *"It makes me happy. Yeah, it would be very difficult to live in an environment where I couldn't see the clouds or the trees or the birds..." - ALJMI_01*

- *“I just love the outdoors here, I mean, wherever you look, there is either trees or flowers or and I think that’s probably why I’m not at all depressed in any way I can. When I get that way, I just look outside and enjoy seeing what there is.” - ICB_05*
- *“To me, that is really important to have something where you can get out physically out of your room, outside, and get air.” - ICB_04*

Many of the participants of this study reflected on positive experiences in nature, viewing natural environments, and sharing memories of when they were able to go outside to hike, garden, or play with their children that they may not have the mobility to do anymore. Feelings of admiration, comfort, wellbeing, life, and peace were described during the interviews to describe the impact that having natural surroundings has on older adults in this type of setting.

Views were seemingly the most accessible and important method of increasing one’s proximity to nature; those who reported having a nice view of water, the mountains, nearby parks or trees, flowers, and the sky were seemingly the happiest with their current living situation and/or choice of apartments. For some, getting outside to explore the grounds of their community campus or take walks to have a dose of nature claimed that they were fearful of being exposed to the elements or being alone in case of an emergency, emphasizing the need for safe and easily accessible areas for outdoor recreation and relaxation. Cover from rain, the sun, and wind is important to protect these hesitant members who desperately want fresh air and a safe place to be outside for themselves.

Overall, nature was a topic most participants identified was a significant part of their lives before moving to a residential care setting and commented that they felt more and more disconnected from natural environments as they aged.

With rich data from over 60 participants, we have barely scratched the surface of all of the outcomes from the data collected; however, it was clear that many of the findings directly related to comfort, behaviors, and energy implications, which are further discussed below.

Discussion

Situationally, many participants told stories of growing up in farmhouses or older homes that lacked the modern comforts we enjoy today such as central heating/cooling, household appliances, indoor plumbing, and lighting. Several participants mentioned that the changes in architecture and city planning have deeply affected their abilities to navigate buildings today, as well as find comfort within them. Modern digital interfaces were technologically unfamiliar to many current senior living residents, as were the “invisible” controls that happen without direct input, as many of the participants of this study expected a cause and effect from opening a window for cooling or turning a knob on the radiator to release more heat.

We heard many stories about adaptive comfort strategies that are intrinsically low energy solutions for occupant comfort as we did counterintuitive comfort strategies that were clear wastes of energy and resources. For example, opening windows for air quality when the air conditioning or heat was on, which many senior participants of this study commented they do on a nightly basis, is not a low energy behavior. However, many occupants could not control their interfaces because they did not understand them, for instance, digital thermostats where they could not actually see the numbers or indicator icons on the screen displays. Many of these interfaces were designed with little consideration of the senior population’s aging eyes and need for higher contrast, larger numbers and symbols, or ability to push small buttons.

In the cases where digital controls are used, education on managing comfort in a modern building would improve comfort of the older population currently residing in modern living communities. This could be addressed by educating occupants on how to properly use, interact with, and program their existing digital thermostat controls to properly self-manage their comfort. In addition, it is imperative that all building interfaces and controls are “senior friendly” such as thermostat interfaces that are large enough, intuitive, and easy to control. Additionally, teaching and reminding occupants to manage their comfort with more “passive” building and “active” occupant behaviors, especially in cases of extreme weather or power outages, is essential for comfort and safety. Encouraging low-energy behaviors can be emphasized as well.

Shocking safety issues were also found through this research, for example, in one location during a heat wave related power outage, a fire door went to close taking down a resident in its path, leading to their decline and death. As illustrated by this devastating story, it is important to think about unintended consequences of particular design features, the ability to maintain thermal comfort for safety, the ability to open/close windows or bypass systems, etc. in the event of power outages and more. Resilient and thoughtful design is necessary, especially as temperatures and energy costs rise.

“... with resiliency in mind, one would hope that the ways in which occupants may need to interact with the building in an emergency (e.g., increased ventilation (pandemics), no outdoor air at all (wildfires), etc.) would be easily achievable ... One must consider, under extreme or emergency conditions, whether the building is designed in such a way that building occupants retain the competence and information needed to maintain functionality and comfort? One can imagine a health and safety code, or alternatively, a “building resiliency rating,” that requires designers to prove that the building can remain fully habitable both with, and without, electric power. For example, even if electric power is unavailable for an extended period, doors and windows can still open and close, thermal conditions and ventilation rates can be maintained within tolerable ranges, water still flows, and there is ample daylight available” (Heschong and Day 2022).

Furthermore, countless stories were told that emphasized the importance of view and access to nature. The importance of access to views and nature is becoming well established, as there are many benefits -- physically, cognitively, and emotionally. The type of view, especially those of natural elements such as clouds, birds, and trees can elevate emotions while enabling feelings of safety from the outside world (Heschong 2021). In senior populations, when many already feel so disconnected from the outside world, views (and good ones with natural elements rather than hardscapes or mechanical equipment) are essential.

Overall, the findings of this research point to several opportunities to gracefully help seniors navigate the changing buildings around them (and the technology integrated within them), improve their overall occupant comfort in the places they spend the most time, increase accessible and equitable access to the outdoors, and steer future senior living developments for the next generation of older adults. Additionally, because occupant behaviors play such a significant role in the energy use and occupant comfort within a building, methods of training and educating building users in energy-efficient comfort strategies could lead to cost, satisfaction, and operational benefits in the senior living industry. Much was learned from this research about the ways that older adults take care of themselves, their environments, and live in a typical modern senior living community.

Ultimately, typical designs (interfaces, spaces, amenities, layout, controls, etc.) are not going to work the same way for the senior population as they might for younger generations due to mobility, hearing, vision, and other physical, mental, cognitive, and emotional changes that occur when someone ages. Some of these issues have been addressed with accessible building standards (ADA), for instance. However, many of the building controls and interfaces available

still do not account for these important changes and needs of the aging population. Therefore, many cannot behave in ways that support their desires or comfort preferences, let alone, mindful energy saving behaviors.

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