

PROMOTING HEALTHY AGING THROUGH
TRANSPORTABLE ACCESSORY DWELLING UNIT COMMUNITIES

A DARCH PROJECT SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAII AT MĀNOA IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF ARCHITECTURE

May 2017

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Keywords: Accessory Dwelling Unit, Transportable, Flexible Architecture

Abstract

Due to Hawai'i's aging population, high cost of living, housing shortage, and limited public transportation, aging in Hawai'i can be challenging. The sprawling suburban neighborhoods commonly found throughout Oahu can lead to the social and physical isolation of many elderly individuals. Isolation which can possibly lead to mental stress with anxiety and depression, can also have negative impacts on physical health. The purpose of this dissertation is to create home and community environments that promote healthy aging. The housing prototype that was explored is an accessory dwelling unit, (ADU), that can be placed on a single-family home lot, or transported to a planned community site comprised of similar ADU units. The uniqueness of this ADU home, is that it can be moved intact, thus allowing the occupant to move locations, yet remain in the same home surroundings. The relocation of the ADU to the planned community will allow the occupant more opportunities for social interaction, physical activity, horticultural therapy, and access to nearby amenities. Therapeutic healthy aging activities are also promoted within the interior of the units through adaptable furniture pieces. Precedent studies of adaptable interior environments, transportable homes, and Metabolic architecture were analyzed for their application to the design of this housing prototype. This dissertation is a new housing model for aging in Hawai'i.

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Preface: Motivation

Humans are social beings. We are always searching for companionship through family and friends. We surround ourselves with people whom we admire and strive to be like in life. I am blessed to have grown up in Hawai'i, with a good home, education and a very supportive and close family. Having lived right next door to one set of my grandparents and my other Grandparents living nearby, in Kaneohe, I became very close with them. I spent much of childhood at their homes and developed a close bond with my Grandfathers. I admired their athleticism, wit, enthusiasm, kindness of heart, supportive manners and hardworking mentalities. I strived to be like them, and participated in activities they enjoyed, such as yardwork and golf. They were always so supportive of everything I aimed to do and pushed me to be the best I could be.

In 2011, my Grandpa Olsen suffered a severe stroke. His right side of his body became paralyzed and his speech extremely impaired. The active, funny, loving man could no longer walk, move his arm, or even speak well. It was an extremely difficult time in our family. He was 88 years old and required around the clock care. My Grandmother was not strong enough to care for him, and my parents had to work full time, so ultimately we could not provide him with the proper care that he needed at home. We had no other choice, but to place him in a nursing care facility, unfortunately against his wishes. The first care facility he stayed in was Oahu Care Facility. He had three other men in the same room, with a curtain as their only form of privacy. He had a small window with a view of the tops of buildings and the sky. I spent much of my free-time sitting with him and tried to keep his spirits up. However, you could see the sadness in his eyes that he was stuck inside this facility and could no longer physically care for himself. He became depressed and begged to come home. We could no longer bear to see him this unhappy and so we brought him home and hired a nurse to come during the day when everyone was at work. At night, my parents and his grandchildren helped to care for him. His home was not appropriately built to ADA standards. The bed had to be moved to the ground floor and the bathroom shower had to be renovated to allow easier accessibility. Ultimately due to an additional health issue, he spent several months at Kuakini Hospital. He later passed away on February 15, 2012.

My Grandpa Sullivan was a Veteran in the Vietnam War and unfortunately had many health issues throughout his lifetime. Despite his health ailments, he was a very strong, disciplined, but fun-loving man. In 2011, his health issues worsened and ultimately he entered the Tripler VA Hospice. Although he received his own room and the facility was clean, he was clearly uncomfortable. Once he entered the facility, he constantly pleaded to come home and enjoy the comfort of his own home and garden. During his one-day home visit, he realized the severity of his pain was too much to bear at home. When he returned to hospice, his health rapidly declined. Three weeks after entering, he passed away on February 16, 2014.

Making the decision as to which type of care a person should receive, is a tremendously difficult decision. My Grandfather spent a large portion of his life, fighting illnesses and physical ailments, constantly in and out of doctor's offices and hospitals. While, I understand hospice is to make those, who have suffered fighting illness, comfortable till they pass, it was a very difficult experience for everyone involved. Many of the available housing and healthcare options provide residents with their needed physical care, but cause negative consequences for their mental health, such as depression and anxiety. Hospice often helps the family prepare but it is also difficult to be with your loved one in a foreign environment. These personal experiences have been the motivation behind my interest and research about aging. As a student of architecture, I sought out a design that would support the seniors of Hawai'i with a new flexible housing prototype. This prototype would allow them to take their transportable unit to a community site, while remaining in familiar environment of the unit.

In January 2016, I interned for the company List Sotheby's International Realty in Japan. This experience completely transformed my outlook on housing and caring for our elderly. Japan's population is rapidly aging due to its declining birth rate. For example, the rate fell from 4.5 in 1947 to 1.5 in 1995.² The second reason is due to a significant decrease in mortality. People are living longer. "The average life expectancy for men increased from 50 years in 1947 to 76.4 in 1995; that for women rose from 54 to 82.8

² Randall S. Jones, "Japan: Population Aging," *OECD Observer*, no. 209 (1997): 34.

years over the same period.”³ Japan has one of the oldest populations in the world and are constantly trying to improve their housing and care for their older adults. During my four and half months in Yokohama, I visited various facilities for elderly. I visited both, traditional nursing care facilities and a more unconventional day care facility.

One of the more traditional facilities that I visited was the Tsukui Nursing Care Facility in Tokyo. The building was seven stories tall with a central interior courtyard that included a small sitting area and Japanese style garden. Adjacent to the Northern side of the building, there is a lush shaded walking path. The view of nature from these rooms, made them highly requested. One of the criticisms of many nursing care facilities in Japan is the location. Many care facilities are far distances from the subway, train stations, and commercial buildings. Also, the amount of greenery and nature is limited due to limited space and urban setting.

In Japan, most nursing care facilities are in suburban areas, far from public transportation. Typically, building a nursing care facility decreases the value of the land. This is due to high cost of land and the low value of welfare centers. However, I visited the Tsukui Sunshine Yokohama-noge facility in Hinodecho. The name means, the City for Three Generations. This facility is one of the first in Japan to locate the elderly care center directly across from a rail station. The building is mixed-use, which includes: commercial businesses, the elderly care center, and apartments. Another great feature of this facility, is that it allows families to live within the same building. Today, Japanese families usually only consist of one or two generations. It is uncommon to have the grandparents living with their children and/or grandchildren. The Tsukui Facility brings in a children’s daycare group, once a month. The children and elderly participate in various activities. Many Japanese children have not spent a lot of time with elderly. This program teaches young children how to interact with older adults and raises the spirits of elderly residents. This integration of three generations under one roof, is the inspiration for the name of the facility.

³ Randall S. Jones, "Japan: Population Aging," *OECD Observer*, no. 209 (1997): 34.

The previous two facilities were more conventional than Yume No Mizumi Mura, in Chiba, Tokyo. This facility has a unique philosophy, that it is better for you to do something yourself, then someone doing it for you. Typically, in many elderly care facilities, it is based on universal design, or barrier free. This is to make the facility more accessible and hopefully to reduce accidents, such as falling or tripping. However, Yume No Mizumi Mura has intentional barriers such as long ramps, stairs, and various activities that stimulate one's mind and body. By constantly having to do these activities, it allows for residents to stay active and healthier longer. This way of thinking drastically changed my thoughts on architecture for elderly. Although it is difficult to determine which stance on care is best, it ultimately depends on the individual's preference. The key is to provide older generations with a variety of options and let them choose which one is best for them. I think architecture that challenges an aging body to move through thoughtful intentional barriers is beneficial, but designs with unintended barriers, such as: small step-ups, narrow doorways and slippery floor materials are impedances and can be dangerous as one ages. There is a balance between promoting physical activity and designing safe environments that needs to be met.

Similarly, to Hawai'i, land in Tokyo is expensive. Consequently, the properties typically have very small land footprints. Therefore, many homes are small and designed with creative storage to make small spaces more comfortable and functional. As a student of architecture, I have studied small structures and transformable furniture that make small spaces more functional. On my home property, there is a small caretaker's cottage that was from the old estate. When my great-grandparents moved to Hawai'i, they lived in the small studio with only their necessary and loved possessions. Both lived here happily until their old age. After their passing, the house was converted into a rental unit, providing income to my grandparents. Through personal experience, I have seen the benefits, for elderly, to have an accessory unit on their property for either a space to downsize in or to rent. Whichever, the additional income from renting either the unit, or main house, will help ease the high cost of living in Hawai'i. With the recently passed, accessory dwelling unit law, that allows for an additional rental unit on single family home property, I saw a possible way to help aging family members, through designing a transportable accessory dwelling unit.

1 Chapter 1: Who & Why

1.1 Demographic Information

Today, across the world, there is a demographic shift occurring. In 2005, the population 65 years and older was 7 percent of the global population. It is projected that over the next fifty years that it will rise to more than 16 percent.⁴This demographic shift threatens the quality of life for the elderly.

Before the 18th century, individuals that reached adulthood had many children and grandchildren, but typically passed away at a young age due to the lack of sanitation, nutrition, health practices, and medical care. Beginning in the 1700s in Europe, living standards improved through better sanitation and housing. Thus, plagues and famines occurred less frequently, consequently reducing the mortality rate. The 20th century experienced even greater improvements in health care and medicine, and the mortality rate was drastically reduced. Infants, children and adults all had higher life expectancies. Finally, in the 1960s there were improvements in medical care for those who already were in old age.⁵ As a result of these improved living standards and medical advancements, mortality rates are at an all-time low and people today are living longer than ever before, especially in developed countries. As life expectancy, has increased, the global birthrate has decreased, resulting in a demographic shift in which the majority of the population is older. Now, with older adults living longer lives, they're faced with adjusting to a longer period of physical deterioration. "The losses of late old age or the Fourth Age (at approximately ages 85 and over) become increasingly difficult to adjust to; *'Living longer seems to be a major risk factor for human dignity.'*"⁶ Without the right preparation and adjustments made to current housing and health care, many elderly individuals will face a difficult experience of growing old.

⁴ United States Congressional Budget Office, *"Global Population Aging in the 21st Century and Its Economic Implications* (Washington D.C.: Congress of the U.S., Congressional Budget Office, 2005), 8.

⁵ Ibid. 12.

⁶ C. Nicholson et al., "Living on the Margin: Understanding the Experience of Living and Dying with Frailty in Old Age," *Social Science & Medicine* 75, no. 8 (2012): 2.

The United States is one of the many developed countries experiencing the demographic change of an aging population. “In 2050, the population aged 65 and over is projected to be 83.7 million, almost double its estimated population of 43.1 million in 2012.”⁷ In addition, life expectancy has increased in the United States. “Life expectancy at age 65 was 15.2 years in 1972 and rose to 19.1 years in 2010- a net gain of 3.9 years.”⁸ The life expectancy of those 85 years increased from 5.5 years in 1972, to 6.5 years by 2010.⁹ While 3.9 years seems like an insignificant increase, this increase of life expectancy changed only over several decades. The baby boomer generation is aging, and began turning 65 years in 2011.¹⁰ They will play an imperative role in the changing demographics of the nation.

Similarly, too much of the United States, Hawai’i also has a steady population growth due to immigration, births, and longer life expectancy. The annual average of births between 2000-2010 was 18,277, 8,965 deaths, and 5,565 of net migration.¹¹ These statistics demonstrate how Hawai’i residents are living longer, along with a significant amount of immigration. The estimated population in 2015 for Honolulu County was 998,714.¹² According to the 2010 census, it was projected that in 2015, 16.2% of the population was 65 years and older.¹³ It is expected that by 2030, nationally 21% of the population will be 65 years and older, while Hawai’i is projected to be even higher at 24%. In Honolulu alone 27% of residents are projected to be 65 years and older by 2040.¹⁴ With Hawai’i experiencing the longest life expectancy in the nation people are projected to live 16.2 additional years.¹⁵ These statistics demonstrate how there is a growing need to prepare, as a state, for this demographic shift, especially by providing

⁷ Jennifer M. Ortman et al., “An Aging Nation: The Older Population in the United States,” *Current Population Reports, P25-1140*. U.S. Census Bureau (2014): 1.

⁸ Ibid. 3.

⁹ Ibid. 3.

¹⁰ Ibid. 1.

¹¹ “Quickfacts Honolulu County, Hawaii,” United States Census Bureau, accessed December 1, 2016, <http://www.census.gov/quickfacts/table/AGE765210/15003>.

¹² Ibid.

¹³ Ibid.

¹⁴ “Making Honolulu an Age-Friendly City: An Action Plan,” The University of Hawaii Center on Aging, accessed October 15, 2016, <http://www.kupunatokeiki.com/wp-content/uploads/2015/07/FINAL-FINAL-Honolulu-Age-Friendly-City-Action-Plan-2015.pdf>. 27.

¹⁵ Ibid. 27.

additional housing options. Currently there are the basic types of housing available to elderly: aging in place, adult day care centers, adult day health, adult residential care homes, assisted living, community care foster family homes, institutional care, and hospice.

1.2 Housing Information

In 2014, the American Association of Retired Persons sent out the Living Communities Survey to Honolulu residents 45 years and older. The survey results indicated that 54% of Honolulu's older adults have lived in their current communities for over twenty-one years, 22% between eleven and twenty years and 21% have lived zero to ten years.¹⁶ 68% of respondents said that it is very important to stay in their communities as they age, and 79% say that it is extremely important to stay in their homes as they age.¹⁷ "For many older adults, aging in place has a broader connotation than simply living in one's home; it is also about their neighborhoods, and aging in a familiar area. Familiarity becomes important as one grows older."¹⁸ This is why many elderly reluctantly move to retirement communities. The transition from a familiar to unfamiliar space can be difficult, even for those who need healthcare. Humans develop attachments to homes and neighborhoods, making moving difficult.

There are many neighborhoods in Hawai'i that have naturally occurring retirement communities, or NORC's. Naturally occurring retirement communities are defined as areas where 40% or more of residents are at least 60 years old or older. There are five NORC's on Oahu: Manoa, Punchbowl, Mo'ili'ili, Kaimuki, and Kaneohe. The communities can be apartment buildings or clusters of single-family home lots.¹⁹ The elderly of Hawai'i, have expressed that they desire to age in place, through these natural older populated neighborhoods.

¹⁶Brittne M. Nelson and Eowna Y. Harrison, *Livability for All: The 2014 AARP Livable Communities Survey of Honolulu, Hawaii Adults Age 45+*, accessed November 15, 2016, http://www.aarp.org/content/dam/aarp/research/surveys_statistics/il/2014/Livability-For-All-The-2014-Livable-Communities-Survey-of-Honolulu-Hawaii-Adults-Age-45-Plus-AARP-res-il.pdf. 7.

¹⁷ Ibid. 9.

¹⁸ "Making Honolulu an Age-Friendly City: An Action Plan," The University of Hawaii Center on Aging, accessed October 15, 2016, <http://www.kupunatokeiki.com/wp-content/uploads/2015/07/FINAL-FINAL-Honolulu-Age-Friendly-City-Action-Plan-2015.pdf>. 71.

¹⁹ Ibid. 74

While there is a desire to age in place, i.e., at home, the survey results showed how it can be difficult to achieve, especially for homeowners. 77% of Honolulu’s 65 years and older are homeowners and 23% are renters.²⁰ Of respondents to the AARP Livable Communities Survey, 41% responded that to age in place they needed to make bathroom modifications, 27% said that needed a new roof or new plumbing, 24% better lighting, 20% installation of medical emergency response, 19% easy access such as ramp or chairlift, 19% better ventilation and cooling, 9% additional bathroom on ground floor and 9% additional bedroom on ground floor.²¹ These home renovations can be stressful for the elderly who are already experiencing physical and mental ailments, such as declining mobility, muscle strength, or memory. Moreover, some renovations, like installing a new roof, or heating and cooling systems, can be deemed too costly for older adults who are no longer working.

1.3 Cost of Living

Despite the fact that Hawai’i is a desirable place to live, it is one of the most expensive places to live in the nation. Hawai’i’s cost of living is 16% higher than the national average. In 2009 49.2% of homeowners were paying 30% or more, of their household income, which the federal government considers a “cost burden.”²² “In July 2014, the median price of a single-family house on Oahu was \$683,500, up 5.6% from the year before. The median price of a condominium was \$351,750, up 1.8%. The median cost of renting a two-bedroom apartment in Hawai’i is \$1,671 a month, about 71% higher than the national average of \$977.3.”²³ The accessory dwelling unit bill is one of the many attempts at providing more affordable housing options in Hawai’i. The bill allows for single family home lots to build a second unit on the property for long-term rental.

²⁰ “Making Honolulu an Age-Friendly City: An Action Plan,” The University of Hawaii Center on Aging, accessed October 15, 2016, <http://www.kupunatokeiki.com/wp-content/uploads/2015/07/FINAL-FINAL-Honolulu-Age-Friendly-City-Action-Plan-2015.pdf>. 72.

²¹ Brittnie M. Nelson and Eowna Y. Harrison, *Livability for All: The 2014 AARP Livable Communities Survey of Honolulu, Hawaii Adults Age 45+*, accessed November 15, 2016, http://www.aarp.org/content/dam/aarp/research/surveys_statistics/il/2014/Livability-For-All-The-2014-Livable-Communities-Survey-of-Honolulu-Hawaii-Adults-Age-45-Plus-AARP-res-il.pdf. 11.

²² “Making Honolulu an Age-Friendly City: An Action Plan,” The University of Hawaii Center on Aging, accessed October 15, 2016, <http://www.kupunatokeiki.com/wp-content/uploads/2015/07/FINAL-FINAL-Honolulu-Age-Friendly-City-Action-Plan-2015.pdf>. 72.

²³ *Ibid.* 70.

Many elderly experience sudden health complications and need affordable care, such as a visiting nurse or caregiver. This options may be too expensive for some. Per the Genworth 2014, Cost of Care Survey Hawai'i, the cost of health care in Hawai'i is much more expensive than elsewhere in the United States. For example, the median annual rate for a homemaker service is \$52,052 in Hawai'i while it is \$43,472 in the rest of the United States, an almost \$10,000 difference.²⁴ For home health aide services, the median annual rate in Hawai'i is \$57,772. For adult day care service, the median annual rate in Hawai'i is \$19,175. For assisted living, Hawai'i's median annual rate for a single occupancy one bedroom is \$57,000. For a nursing home, the median annual rate for a semi-private room is \$121,545 and a private room is \$135,050. The disparity in price is staggering. As discussed in Section 1.2, much of older adults in Hawai'i wish to age within their home, but if we take into consideration the effect of an elderly individual's health condition on which type of care is most effective, some older adults may require more care, which can become costly. The high price of healthcare for the elderly in Hawai'i, in conjunction with the price of possible renovations, reveals how older adults are less likely to age in their own home and remain financially stable.

1.4 Desires of Oahu's Elderly

On the island of Oahu, most community spaces, and amenities are located within the densely populated city of Honolulu. Residents living within these communities, have the convenience to walk to many of these features. Even most suburban communities, on Oahu, have basic amenities such as grocery stores, parks, banks, and healthcare services. However, these suburban communities are less dense, and spread out over a farther distance. Especially for elderly, this increases the time and effort it takes to access these features. This increase in distance, intensifies resident's everyday reliance on cars. If an individual is no longer able to drive, their community engagement and access to basic needs is severely decreased. As such, this distance can lead to isolation. Though Oahu has an expansive bus system, the distance between their homes and bus stops is too far

²⁴ "Genworth 2014 Cost of Care Survey Hawaii: State-Specific Data," Genworth Financial Inc., accessed November 26, 2016, <https://www.genworth.com/dam/Americas/US/PDFs/Consumer/corporate/Hawaii-040114.pdf>. 10.

for some older adults. In the AARP survey mentioned above, 66% responded that conveniently located entertainment was very important, 66% responded that activities to meet other older adults is very important, and 75% mentioned that easy access by public transportation to activities was needed.²⁵ While social events are deemed important by Honolulu's older adults, 44% are unsure if they available. As mentioned in section 1.2, Hawai'i's elderly wants to remain in their homes or neighborhoods. Only eleven percent deemed their communities as poor places for older people.²⁶ While many of Hawai'i's older adults are content with their current homes and neighborhoods, there are areas in which could see improvement.

Though Hawai'i is a great place to grow old because of the warm weather, ample beauty and "aloha spirit", the high cost of living has created a housing crisis. The cost of rent, mortgage, or everyday expenses makes it difficult for elderly individuals to age in their homes since they no longer have an income. In addition, Hawai'i's sprawling suburban neighborhoods can also promote isolation of the elderly because of the lack of easy access to community spaces, public transportation and commercial spaces. Many elderly in Hawai'i, choose to move out of their single-family homes, to housing specifically designed for aging, because of a closer location to amenities, available services and care, and safer living environments. There are several current housing and care types available to elderly on Honolulu. While these options provide many with the care and housing necessary, there is an urgent need for more affordable and practical housing options. Nonetheless, we must look at the existing housing options, to understand the issues at hand.

²⁵ Brittnie M. Nelson and Eowna Y. Harrison, *Livability for All: The 2014 AARP Livable Communities Survey of Honolulu, Hawaii Adults Age 45+*, accessed November 15, 2016, http://www.aarp.org/content/dam/aarp/research/surveys_statistics/il/2014/Livability-For-All-The-2014-Livable-Communities-Survey-of-Honolulu-Hawaii-Adults-Age-45-Plus-AARP-res-il.pdf. 26.

²⁶ *Ibid.* 12.

2 Chapter 2: Current Available Housing and Care

The Hawai'i Department of Health and the Hawai'i Department of Human services, regulate most long-term care facilities.²⁷ The care and housing options for elderly in Hawai'i are broken down by the level of care that the individual needs. The options are also dependent on how much one is willing or able to pay, the facility availability, their health insurance, the condition of their home, and the availability of their family members for additional care. "Informal, unpaid caregivers provide the vast majority of LTC services in the United States."²⁸ However, many children move away from their parents, and are not able to provide that informal care. This leads many to rely on the state's provided care options. These various care options vary from living at home, to moving into a nursing care home with 24-hour care. On one hand, an affluent elderly individual with mobility issues could afford to hire a live-in nurse and thus age in their own home. On the other hand, a middle-class individual with similar mobility issues, may be unable to pay for home renovations or in-home assistance. They may eventually need to enter a nursing care facility. These decisions are ultimately dependent on the individual, and not all options are right for someone. In this chapter, the basic types of housing will be discussed. Having a clear understanding of the available housing and care, specific for elderly, help to uncover the issues that each type has, hopefully leading to new types of housing, which fix those issues. The pros and cons of each will be briefly described for aging in place, adult day care centers, adult day health, adult residential care homes, assisted living facilities, community care foster family homes, institutional care, and hospice.

2.1 Aging in Place (Single Family Home or Apartment)

Aging in place is the most desirable option for elderly because many of them have established a deep connection with their homes and neighborhoods. This is one of the many benefits of aging in place. By having the ability to stay in one's home, they are comfortable with their environment. Another benefit is that the elder can still retain a

²⁷Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 4

²⁸Ibid. 4

certain level of independence. Furthermore, they typically have access to more friends and family if they age in place.

Aging in place, however, is not without its drawbacks. Many single-family homes are not close to any amenities, and for seniors, the distance between their homes and nearby amenities may be too far a distance to walk. “Without realistic transportation supports, it may be impossible or impractical for an individual to remain at home. While some individuals are fully and independently mobile, a large number of people do have significant difficulty getting to and from appointments.”²⁹ Mobility issues hinder social interaction and possibly one’s nutrition. Social interactions depend on the elderly’s mobility by foot and public transportation. For those that have access to transportation, the City and County of Honolulu Department of Parks and Recreation provide the Senior Citizens Program and the Senior and Community Centers.³⁰ However, without transportation, many are unable to participate in these available social activities. There are also available meal services, such as Meal on Wheels. For many, the daily delivery of their meals, may be their only social interaction.

Some seniors who age in place require an in-home nurse to come every day. There are two types of in home care, skilled or non-medical care, also known as homemaker service. For those that do not need daily assistance, but less frequent care, the skilled home care, can be provided by home health agencies. Both options can become costly.³¹ “The Home Health Agency (“HHA”) is an entity “primarily engaged in providing direct or indirect skilled nursing services and other therapeutic services under a physician’s direction to homebound patients on a part-time or intermittent.”³² basis.” Therefore, the healthcare official may not be with them all day and night. Besides costs for healthcare, there are costs for the modifications needed to be done to the house to make aging in place safer. Due to the reduction in mobility, some senior adults are unable to perform housework and thus live in unsanitary conditions.

²⁹ Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 4

³⁰ *Ibid.* 4.

³¹ *Ibid.* 5.

³² *Ibid.* 5.

Though there are negative aspects to aging in place, the increased mental happiness associated with aging in place makes it the preferred type of housing for the elderly. A clinical study completed to test the outcomes of aging in place (AIP) in comparison to nursing care facilities for long term care. The results were based on these categories: cognition, depression, incontinence, functional status and pressure ulcers. The participant's ages ranged from 50 to 94 years old. The participants that were aging in place had significantly better outcomes than nursing care residents in the following areas: activities of daily living (ADL) functioning, cognition, depression and incontinence. "Declining ADL and cognitive functioning are two major factors related to institutionalization of older adults."³³

"Cognitive function and mental illness have been dynamically linked to decline in physical functioning. It is interesting that ADL, cognitive status, and depression improved and then declined at a slower rate in the AIP group than in the 'nursing home' comparison group. One explanation could be that remaining in one's home and maintaining independence contributes to the more positive outcomes."³⁴

2.2 Adult Day Care Centers

Adult Day Care Centers, (ADCC) provide the elderly with a place to go to during the day to be active and social. The services are facilitated by the Hawai'i Department of Human Services. "An ADCC is a licensed facility maintained and operated by an individual, organization, or agency for the purpose of providing regular

Figure 1 Sakura House Adult Day Care in Hawaii

Source: "Sakura House Adult Day Care Program: Services Provided," Sakura House, accessed November 22, 2016, <http://www.sakurahousehawaii.com/>.

³³ Karen Dorman Marek et al., "Clinical Outcomes of Aging in Place," *Nursing research* 54, no. 3 (2005): 6.

³⁴ Ibid. 7.

supportive care to four or more disabled adult participants, without charging a fee.”³⁵ Each facility and their amenities will vary. Some are designed similar to a family-style residence, while others are designed for more community spaces. The main goal of adult day care facilities is to provide help with everyday activities.

“Services for ADCC participants include observation and supervision by center staff, proper notification to a primary caregiver of the participant’s wellbeing, counseling and referral to appropriate services, certain limited assistance with medications, meal services, and activities to enhance an individual’s well-being. Many of the activities will include therapeutic, social, education, and recreational events, such as arts and crafts, exercise, hobbies, reading, excursions and community activities.”³⁶

To be eligible to utilize Adult Day Care Centers, one must be unable to function independently and need regular care.³⁷ The day care centers allow the elderly to technically “live” in their current home, but also receive the social and physical activity needed to keep the mind and body agile. While, it is effective in providing activities for elderly to do during the day, living at home alone, leaves them vulnerable to falling incidences at night. The day care service, also does not improve or modify the existing house to make it more age appropriate. An example of an adult day care on Oahu, is the Sakura House. This facility provides medical care, as well as, various planned activities to keep them active.³⁸ The benefit of a day care facility is it helps to get elderly out of their homes and socializing with others. The Sakura House offers activities, daily monitoring, breakfast and lunch, excursions and assistance with basic everyday tasks.

2.3 Adult Day Health

Individuals that utilized the Adult Day Health, go home at night, which is like Adult Day Care Centers. Currently there are approximately ten Adult Day Health Centers

³⁵Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 5.

³⁶ Ibid. 5.

³⁷ Ibid. 5.

³⁸ “Sakura House Adult Day Care Program: Services Provided,” Sakura House, accessed November 22, 2016, <http://www.sakurahousehawaii.com/>.

in Hawai'i, six of which are located on Oahu.³⁹ These facilities provide, “medical services, nursing services, dietetic services and planned therapeutic and social activities are available to meet the assessed needs of clients...”⁴⁰ To utilize this facility, one must have a referral from a community of health agency, physician or hospital.⁴¹

This service’s advantages and disadvantages are similar to Adult Day Care Centers, but they also provide more medical services, such as physical, occupational or speech therapy. Adult Residential Care Homes

Adult Residential Care Homes are also known as, ARCH, which have three different types: Type I, Type II, and Expanded ARCH.⁴² Adult Residential Care Homes provide housing in a social setting. Type I can accommodate up to five residents and Type II can accommodate six or more residents.

“Residents of both Type I and Type II ARCH facilities require, ‘at least minimal assistance in the activities of daily living, personal care services, protection and health care services, but who do not need the professional health services of an intermediate, skilled nursing, or acute care facility.’”⁴³

These homes are for those who do not require as much care or assistance. The Expanded ARCH provides a higher level of care.

“An expanded ARCH is a facility providing ‘twenty-four hour living accommodations, for a fee, to adults unrelated to the family, who require at least minimal assistance in the activities of daily living, personal care services, protection, and health care services, and who may need the professional health services provided in an intermediate care facility or skilled nursing care facility.’”

These facilities like many of the available care options for elderly, require individuals to move out of their homes, and into a facility or home. This, as mentioned

³⁹ “Adult Day Health Centers,” State of Hawaii, Department of Health, accessed March 4, 2017, <http://health.hawaii.gov/ohca/medicare-facilities/adult-day-health-centers/>

⁴⁰ Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 5.

⁴¹ *Ibid.* 5.

⁴² *Ibid.* 6.

⁴³ *Ibid.* 7.

before, can have negative effects on one's mental health. The benefit of the Adult Residential Care Homes, is that it is considered more affordable than institutional care, as well as, a less sterile environment compared to nursing homes.⁴⁴ If the medical issue is severe or progressive, ARCH's may not be the appropriate type of care.

2.4 Assisted Living

Depending on physical and mental abilities, some seniors may require some medical care but are still able to function and live independently. For these older adults, assisted living facilities can provide such care while allowing them to retain a certain level of independence at the same time. Assisted living facilities vary greatly according to size, independence and levels of care provided. The facilities range from single-family homes to large apartment complexes. Having these large variations in facilities and their amenities meet more consumer preferences.⁴⁵ "Depending on the facility types, 15-37% of residents have at least one functional impairment; 23-42% have moderate or more severe cognitive impairment; 13% are depressed; and while more than 90% of residents participate in at least one social activity per week, those who are cognitively or functionally impaired do so less often."⁴⁶

Besides providing needed care assistance and independence, assisted living facilities also provide the opportunity for social interaction. For older adults who enter a long-term care facility, contact with family members, or friends decreases by one half.⁴⁷ Many assisted living facilities provide community spaces for social activity between residents and visiting friends and family. "Settings that encourage supportive interpersonal relationships are associated with better resident function, and social engagement is associated with multiple positive outcomes including decreased mortality, slowed functional decline, and less depression and agitation."⁴⁸ Though there is little

⁴⁴ Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 6.

⁴⁵ Sheryl Zimmerman et al., "An Observation of Assisted Living Environments: Space Use and Behavior. (Housing Outcomes)(Report)," *Journal of Gerontological Social Work* 49, no. 3 (2007): 186.

⁴⁶ *Ibid.* 186-187.

⁴⁷ *Ibid.* 187.

⁴⁸ Sheryl Zimmerman et al., "An Observation of Assisted Living Environments: Space Use and Behavior. (Housing Outcomes)(Report)," *Journal of Gerontological Social Work* 49, no. 3 (2007): 187.

scholarship on the relationship between facility design and resident's behavior, designers still attempt to promote social interaction through the design of space and architecture.

A study was conducted in Florida, Maryland, New Jersey and North Carolina through the Collaborative Studies of Long Term Care of 1,830 residents in 182 facilities. The results concluded that typically smaller facilities had more residents in public spaces. Also, in facilities that offered more activities, more residents were awake, engaged and less were agitated.⁴⁹ Traditional facilities had the least number of residents engaged. The observations also indicated that,

“during the midafternoon, most residents are awake (79%), and one-half (49%) are awake and in public spaces. Residents who are cognitively and functionally impaired are more likely to be in public spaces, but less likely to be engaged. Residents who are awake and alone in private spaces are less likely to be impaired, but more likely to have medical conditions. Thus, residents needing

Figure 2 The Plaza at Waikiki Assisted Living Facility

Source: “The Plaza Assisted Living,” accessed March 10, 2017

<http://www.theplazaassistedliving.com/locations/waikiki>

⁴⁹ Sheryl Zimmerman et al., "An Observation of Assisted Living Environments: Space Use and Behavior. (Housing Outcomes)(Report)," *Journal of Gerontological Social Work* 49, no. 3 (2007): 192.

more oversight seem to be positioned to obtain that oversight.”⁵⁰

This study is significant because it provides evidence of what features of assisted living facilities are successful. An example of an assisted living facility on Oahu is the Plaza at Waikiki. The facility offers independent living, assisted living, and memory respite (short-term stay). The types of rooms are a studio, semi-private (double occupancy room) and a one bedroom.

2.5 Community Care Foster Family Homes

The Hawai'i Department of Human Services facilitates the Community Care Foster Family Homes are also known CCFH.

“A CCFH must provide twenty-four hour living accommodations, personal care, and homemaker services for no more than two adults at one time, at least one of whom shall be a Medicaid recipient and who require a level of care equivalent to those provided in a nursing facility. The level of care requirement limits the use of these facilities to people who are much less independent than those who may utilize other types of community-based programs, such as assisted living or senior housing.”⁵¹

This type of care setting is much more comfortable than institutional care because it is in a home setting, but must still be licensed for skilled nursing. There are also less residents, which can be both positive and negative. Less residents means more one-on-one care and attention, but it also means less chances for socialization with a larger variety of people. Another negative is that these Foster Homes can be located within a single-family home, which may be located a far distance from public facilities. However, this may not be an issue if they are not mobile enough, or if the care provider provides transportation.

⁵⁰ Ibid. 186.

⁵¹Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 7.

2.6 Institutional Care

Institutional care contains intermediate care facilities and skilled nursing care within its umbrella.

“An intermediate care facility, ICF, is defined as a ‘health facility to which a physician has referred individuals who do not need twenty-four hours a day skilled nursing care but who do require... twenty-four hours a day assistance with normal activities of daily living... and care provided by licensed nursing and paramedical personnel on a regular, long-term basis.’ A skilled nursing facility provides ‘skilled nursing and related services to residents who require, twenty-four hours a day medical or nursing care, or rehabilitation services, including but not limited to physical therapy, occupational therapy, and speech therapy services.’⁵²

This type of housing is for individuals who need constant medical care because of serious physical or mental impairments, such as mobility loss and dementia, among others. These individuals, unable to live on their own, need supervision and assistance. The facilities are required to provide, “nursing services, dietary services, physician services, rehabilitation services, dental services, pharmaceutical services, and may provide adult day health services.”⁵³

Figure 3 Oahu Care Facility in Honolulu

Source: “Oahu Care Facility: Our Services,” Oahu Care Facility, accessed November 22, 2016,

⁵² Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 7.

⁵³ *Ibid.* 7.

A benefit of this facility is that it provides the needed care, with most of the necessary health services within one facility. One significant issue with this type of facility is that individuals are usually required to move to these facilities against their own will because family members or themselves are unable to provide sufficient care. The design of many facilities, especially here in Hawai'i, are designed according to healthcare regulations and lack a human and home-like quality. Currently, there are forty-nine licensed nursing facilities in Hawai'i.⁵⁴ A local example of institutional care is the Oahu Care Facility in Honolulu.⁵⁵ This facility offers residents 24-hour care. The rooms are shared between four beds and divided by curtains. Since institutional care is sometimes long-term, this can take a toll on the resident's mental health. Many become depressed because of separation from their home and lack of control over their current environment. For health reasons, most facilities do not allow animals or many plants, even though there are studies that prove that there are health benefits to their integration.

2.7 Hospice

Hospice care is for individuals whom are considered terminally ill. "The health care involved is generally palliative and not curative. In other words, Hospice services tend to address the comfort of a patient, rather than trying to cure the patient from a particular medical condition."⁵⁶ Currently there are ten licensed hospice facilities in Hawai'i.⁵⁷ The goal of this type of facility is to make resident's terminal illnesses as comfortable as possible, while preparing the family for their passing.

This type of facility allows individuals who no longer wish to fight their illness a place to pass peacefully. It is difficult however, for individuals and families to determine whether one should enter hospice. Doctors whom suggest it must inform them of everything very clearly as to not confuse this type of facility with nursing facilities, which try to cure illnesses.

⁵⁴ "Skilled Nursing/Intermediate Care Facilities," State of Hawaii, Department of Health, accessed March 30, 2017, <http://health.hawaii.gov/ohca/medicare-facilities/skilled-nursingintermediate-care-facilities/>

⁵⁵ "Oahu Care Facility: Our Services," Oahu Care Facility, accessed November 22, 2016, <http://oahucarefacility.com/>.

⁵⁶Scott Suzuki, "Long-Term Care in Hawaii," *Hawaii Bar Journal* 19 (2015): 9.

⁵⁷ "Hospice," State of Hawaii, Department of Health, accessed March 30, 2017, <http://health.hawaii.gov/ohca/medicare-facilities/hospice/>

2.8 Common Issues with Current Housing

One of the most important benefits of day care, assisted living, and institutional care is that elderly individuals receive care and assistance in facilities that are designed specifically for their needs and accessibility. For those whom choose to age in place, they may need to remodel their home. There are three areas that are the most common safety issues: “the outside steps to the home’s entrance, inside the stairs to a second floor, and unsafe bathroom areas.”⁵⁸ Common issues found within all different housing options are: wheel chair accessibility was limited by hallway and doors widths being too narrow, insufficient supportive technology for those with hearing and eyesight issues, unsafe access to fixtures in bathrooms, difficulties with household appliances such as refrigerators, stoves, washing machines and driers, windows are too difficult to open and close, flooring material is too slippery and dangerous, thick ‘high pile carpet’ is difficult to use a wheelchair on, inaccessible cabinets that are too high or too low, exterior sliding glass doors that are too heavy to access the garden or deck, ramps are too steep and slippery, not enough sound insulation to prevent noise transferring to other apartments, door knobs, and fixtures are difficult to grasp, slippery floor materials in bathrooms and kitchen sink is either too high or too low for easy access.⁵⁹

“Eliminating hazards in the home lowers fall risk. According to Rubenstein, between 35% and 45% of falls are attributed to home hazards such as inadequate bathroom grab rails and stairway railings, poor lighting, clutter on the floor, exposed electrical cords, and loose throw rugs.”⁶⁰

2.9 Changes in Technology & Changes in Healthcare

Technology has advanced significantly in the last few decades. Once deemed technological dreams, advancements such as ‘smart homes’ are now becoming reality. “New technologies, as used in so-called ‘smart houses’, such as ‘voice butlers’ and the

⁵⁸ Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL : Human Kinetics, 2005), 153.

⁵⁹ C. Kenneth Meyer, "The Senior Housing Shuffle Connecting Public Policy to Universal Design, Sustainability, Health Management, and Aging in Place," *Journal of Business Case Studies* 10, no. 4 (2014): 389.

⁶⁰ Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL : Human Kinetics, 2005), 153.

like, make it easier for the ‘silver surfer’ to manage everyday needs.”⁶¹ Even every day basic technology, such as a robotic vacuum that periodically vacuums the floor on a timer, will ease the more difficult tasks for aging adults. These advances in technology are providing the elderly with more independence. Adults who are now approaching senior age are going to be more technologically savvy than previous generations and rely on ‘smart technology’ for their basic needs. Technological advancements will not only provide more safety precautions, but also make healthcare more accessible in the home.

With the move to have elderly live in their homes, there is now technology that seeks to respond to injured elderly individuals at home. There are healthcare programs online, such as Hawai’i Pacific Health’s My Health Advantage program, which allows individuals to communicate with their doctors from home. They have access to their medical history and the ability to refill prescriptions and ask doctors questions through email.⁶² There are advanced toilets that will test an individual’s urine and fat analysis and then send the results to their doctor.⁶³ At the Kameda Medical Center in Japan experts have designed a bedside computer that compiles patient’s medical history and then translates the information into a long-term health history.⁶⁴

For emergency situations, there are necklaces and bracelets that seniors can wear. If they fall or have a health crisis, they can press a button that immediately connects them to an operator. The operator will ask if they need assistance, call a family member, or send an ambulance. This technology has helped to save many elderly individuals from dangerous situations and provided them with vital, rapid health care.

Furthermore, technology has made communication much easier and efficient. With the invention of Skype and Apple’s Facetime, the elderly now have the opportunity to have visual conversations with family and friends across the globe. The Internet is also another form of socialization for the elderly. Being informed on news and having that connection to society through their computers creates another outlet for socialization.

⁶¹ Eckhard Feddersen, *Living for the Elderly a Design Manual*, (Basel : Boston : Birkhäuser, 2009), 14.

⁶² “My Health Advantage,” Hawaii Pacific Health, Accessed December 1, 2016, <https://www.hawaiipacifichealth.org/patients-visitors/myhealthadvantage/>

⁶³ Eckhard Feddersen, *Living for the Elderly a Design Manual*, (Basel : Boston : Birkhäuser, 2009), 15.

⁶⁴ *Ibid.* 28.

Japan's way of responding to the high demand for socialization among the elderly is through "robotic social aids such as the robotic dog 'Aibo', a replacement for a real four-legged friend, or 'Paro', an artificial baby seal that serves as a pet for elderly people in residential homes."⁶⁵ With online shopping and various internet services, there is less need to leave the house. The convenience of online shopping makes everyday tasks simpler. However, this convenience reduces the amount of opportunities for socialization.

Elderly form relationships with people who provide daily services for them. For elderly, the basic tasks of going to the grocery store, collecting the mail from the mailman, speaking with the bank teller, maybe the only socialization they have that day. Therefore, in the future, more elderly may be more socially isolated because of the convenience of the internet and technology. As designers, it will be important to provide spaces for socialization in neighborhoods, and to promote leaving their homes.

While most of these examples are well-known today, scientists and healthcare experts will continue to design more progressive technology and healthcare equipment that will change the way people live in the near future. It is important to acknowledge that the soon-to-be elderly demographic of the next few decades are not the same socially, politically, or economically as seniors today. Instead, they will be more technologically savvy and possess more of an environmental sustainability consciousness than previous generations.⁶⁶ Since architects design for people, we must seek to understand lifestyle changes unique to certain age groups, locations, and cultures. Architects must understand their client's lifestyles to provide stimulating and healthy environments that meet their needs. There are many issues with the current housing types available for elderly. Especially as the population continues to grow, there is an increasing need for more housing options. Consequently, to design healthy environments for our elderly, there must be a clear understanding of the definition of aging, what kind of ailments may accompany it, and what older adults value. I will explore these areas in Chapter Three.

⁶⁵ Ibid. 18.

⁶⁶Eckhard Feddersen, *Living for the Elderly a Design Manual*, (Basel : Boston : Birkhäuser, 2009), 15.

3 Chapter 3: Understanding Aging

In life, when do we stop developing and begin aging? While no one wants to grow old, it is an inevitable process that affects everyone. So how is aging defined? According to the book, *Physical Dimensions of Aging*, “Aging refers to a process or group of processes occurring in living organisms that with the passage of time lead to a loss of adaptability, functional impairment, and eventually death.”⁶⁷ There are many ways in which aging is categorized. Aging can be defined by the numerical equivalent to how long something has been around. Age can also be defined by the biological age of someone, which considers the individual variables that go against the typical chronological age.⁶⁸ We all age differently, because of our genetics, gender, disease, lifestyle choices, differential rates of systems, culture, society, education, biological variability, research design and process and compensatory behavior.⁶⁹ The different combinations of these factors lead to many different outcomes of aging. Many people do not have an issue with growing old. It is, however, the physical and mental ailments that typically accompany aging that are undesirable. The development of physical and mental ailments has led to the categorization of an individual’s health into different levels of necessary health care. This next section will break down common age categorizations found in various societies.

3.1 Current Age Categorizations

There are various established conceptualizations of aging. One popular theory is the Laslett’s Third Age.⁷⁰ “The Third Age is a time of comparative independence: ‘freedom from the demands of earlier life, freedom from the need to earn a living, freedom from responsibilities for others’. Paradoxically, it is the responsibilities of family, work, and community that are major determinants of self-identity.”⁷¹

⁶⁷ Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL : Human Kinetics, 2005), 5.

⁶⁸ Ibid. 45.

⁶⁹ Ibid. 34.

⁷⁰ Lyn Geboy, Keith Diaz Moore, and Erin Kate Smith, "Environmental Gerontology for the Future: Community-Based Living for the Third Age," *Journal of Housing For the Elderly* 26, no. 1-3 (2012): 46.

⁷¹ Ibid. 46.

This form of categorization has become the foundation for many elderly housing facility designs. There are many design guide books that define how we should design for the Third Age, such as *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing* by David Robson. Within the Third Age, there are smaller categories for how much care is needed. There is also another ‘age’ developing, the Fourth Age, which is those approximately 85 years and older. This time in life is determined to be a time of increased frailty, which is difficult for many to adjust to.⁷²

The elderly population is very diverse and thus requires assorted types of housing. Today, there are elderly housing types that have been available for decades. However, as the population increases and our lifestyles transform, new housing types are required. To figure out what new type is needed, the current types must be understood for their advantages and disadvantages. In the UK, the housing categorizing are listed as so:

“Level 1: non-specialized and non-adapted dwellings (‘staying put’ or living with relatives.)

Level 2: independent dwellings which have been purpose-built or adapted for fit and active elderly who may need some support but can generally look after themselves.

Level 3: purpose-built, self-contained dwellings (to mobility standards) in groups with warden attendance and minimal communal facilities, for active elderly (corresponds to ‘Category I’)

Level 4: purpose-built, self-contained dwellings (to fully mobility and wheelchair standards) in groups with warden attendance and access to communal facilities, for physically frail elderly (corresponds to ‘Category II’)

Level 5: similar to Level 4 but with extra care support available and the option to take communal meals, sometimes referred to as Category 2.5

Level 6: residential care homes for elderly who may be mentally and physically frail and in need of constant personal care

⁷² Nicholson et al., "Living on the Margin: Understanding the Experience of Living and Dying with Frailty in Old Age," *Social Science & Medicine* 75, no. 8 (2012): 1.

Level 7: nursing homes for elderly who are sick or very frail and need qualified nursing care”⁷³

While these levels are recognized in the UK, the ideas are universally understood. Within each of the levels listed above there are examples of specific housing types. Level 1 has the most sought after option for elderly, which is to age in place. This option has elderly living in their own home with family members. One of the positives of this option is that they are still surrounded by their community of friends and family. They have a familiarity with the neighborhood and home, which provides them with a sense of security. Some of the general negative features of living alone are possible isolation and lack of access to necessary amenities. The home that they live in may not be suitable or easy for their daily activities. The other option within level 1 is to move in with family members.⁷⁴ This option is good because they have daily interactions with their family members. However, this option usually requires them to move away from their home, which can be traumatizing for some. These homes also may not be well-suited for elderly and would require renovations to bring them up to standards.

In level 2, there is retirement housing, which is designed to the barrier-free design standard. There are two options: detached bungalows in suburban areas and ‘retirement flats’ in more urban areas. The detached bungalows offer elderly the option to live in a smaller space ranging between 645 to 754 square feet with two bedrooms, a dining-kitchen, and a sitting-dining room.⁷⁵ A negative of the detached bungalows stems from their suburban location—the elderly residents do not have easy access or convenience to necessary amenities. The ‘retirement flats’ are apartments geared towards elderly. These sometimes can be difficult because they are off the main ground level, and not all of them provide elevator access.

⁷³ David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 8-9.

⁷⁴ Ibid. 9.

⁷⁵ Ibid. 9.

Level 3 offers housing that consists of “self-contained dwellings.”⁷⁶ These dwellings can be clustered detached bungalows or terraced bungalows. The units have a resident supervisor to check on residents. These units are typically cheaper to build and maintain than apartment style buildings. These also offer more opportunities for natural sunlight.

Level 4 is similar to level 3, but includes some community amenities within the facility, such as lobby space, hairstylist, guest rooms, laundry room and an office for the resident supervisor. The units range from 270-323 square feet for studio style, 430-484 square feet for one-bedroom and 592-700 square feet for a two-bedroom unit.⁷⁷

Level 5 aims to fix the issues of level 4’s inadequacy for mobility and ADA standards, and provides more services found in level 6.⁷⁸ However, level 6 can be expensive and take away a lot of elderly’s independence.

Level 6 consists of residential care homes, where elderly stay in bedrooms individually or with multiple people, use community rooms and receive around the clock “domestic support and care.” These types of facilities are extremely expensive to run. The quality of homes varies because they are privately run facilities. The typical room size is 270-323 square feet.⁷⁹ These facilities offer everything someone needs, which reduces the necessary mental and physical effort needed to do task. While typically, this is accepted as beneficial, it can be detrimental to their physical and mental well-being. Their loss of environmental control, can lead to depression with residents.

Level 7 consists of full-time care for residents and is typically very expensive⁸⁰. It is for either the very physically or mentally frail. The facilities are inspected by the health department and must follow a strict set of design guidelines. The benefit of this housing is that the elderly get the help and care that they need since they are no longer able to do things for themselves. Besides the facility being very expensive, other negatives include

⁷⁶ David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 10.

⁷⁷ Ibid. 11.

⁷⁸ Ibid. 13.

⁷⁹ Ibid. 13.

⁸⁰ Ibid. 14.

residents losing all independence and living in a usually typically in very sterile and cold environments. Many residents become depressed because of the separation from their home, friends and family.

Even though these are the guidelines for aging and healthcare facilities in the United Kingdom, the breakdown of the information is universal. The categorization of the stages of aging and care helps determine a completely different facility or housing that is needed for that stage. While, this current method provides the elderly with the care they need, this type of housing and lifestyle requires the residents to move residences more than one may like to. Many, too, do not think that they will need medical care as they age. However, it is inevitable that changes of the body and mind will occur as one ages. For those who do not plan and adjust their homes, or lifestyles, for those changes, they may have to move into a care home or nursing care facility because of lack of time or money.

Another method of life categorization comes from Herrad Schenk's *The Adventure of Growing Old: On Growing Old & Staying Young*. This life categorization is composed of three phases of life: the go-gos (55/60 to 70/75 years of age), the slow-gos (70/75 to 80/85 years of age and the no-gos (80/85 years of age and older.)⁸¹ The names for each category are self-explanatory and pertain typically to the mobility and independence of elderlies. This categorization is according to numerical age and assumes that within that age group, individuals typically have certain mental and physical attributes. The issue of using this form of categorization is that the elderly in the United States and many other countries are experiencing a phenomenon called 'down aging,' which means that individuals feel fifteen years younger compared to those from thirty years ago. Many with the numerical age that considers them elderly are very productive and independent. As people live longer and are 'staying younger' longer, the population increases thus, increasing the demand for more of a variety of housing options needed.

While these traditional categorizations of aging help to organize the larger population into subcategories, many elderly individuals do not perfectly fit into these

⁸¹ Eckhard Feddersen, *Living for the Elderly a Design Manual*, (Basel : Boston : Birkhäuser, 2009), 42.

categories. With the increasing population, the variety of elderly and their preferences will also increase. Everyone develops mental and physical ailments in different combinations, at different ages, and of different severities. When thinking about our environment and how to design for growing old, it is important to understand the fundamentals of the aging body and mind. Therefore, in the next few sections, the rudiments of physical and mental health will be explained, as well as potential design suggestions to better the environment for aging.

3.2 Physical Health

As we grow older, our physical composition constantly changes. These changes, over time, affect the ways in which we perceive and use our surrounding physical environment. We may experience, mobility loss, dexterity loss, strength and fitness loss, breathing issues, incontinence, mental frailty, impaired vision, impaired hearing, impaired sense of smell, impaired sense of touch, or increase sensitivity to temperature extremes.⁸² Not everyone will experience these impairments, but they will experience at least a few since physical and mental health are strongly correlated. Those that experience mobility loss may also have difficulty walking, standing, and walking up and down stairs or steps. They may also have difficulty bending and reaching for items that are placed too high or too low. Many who have these impairments may need a walker, cane or wheelchair. Individuals that experience strength and fitness loss may have difficulty walking long distances, lifting heavy objects or a feeling of tiredness after physical exertion. These individuals may prefer to use the elevator, ramps or limit the amount of walking. Dexterity loss can cause many issues with participating in daily activities. For example, they may have difficulty opening items like jars, doors, windows and buttons on clothing. Another issue is losing one's sense of touch. Those that experience this may have difficulty sensing heat through touch. Metabolic rate changes can cause many to have a higher sensitivity to temperature variation as we age. This higher sensitivity can also be due to the inability to maintain body temperature, leading to

⁸² David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 13.

hypothermia or heat stroke. Our breathing ability can cause shortness of breath, asthma, sensitivity to smoke or the inability to take deep breaths. While breathing can strain one's physical abilities, sight issues can affect one's depth perception. Humans rely on our eyesight for 90% of the environmental data we learn every day. Partial, short, long, blurred or total blindness can cause mobility issues such as tripping and falling, which reduces the number of activities elderly participate in. We also rely on hearing for most of our daily communication. Partial or total hearing loss can cause difficulties with communicating with others and hearing emergency sounds. Many take the ability to control their bladders and bowels for granted. As individuals age, the ability to control these urges may be reduced. This can cause illness or anxiety to participate in activities. We rely on food to nurture and power our bodies, but the development of digestive issues can lead to many other health issues such as, loss of appetite, weight loss, diabetes, restrictive diet, dry mouth, and difficulty chewing. The last impairment that affects a person's physical health is losing their sense of smell. Loss of sense of smell can lead to loss of appetite and the safety issue of not detecting a fire through smoke.⁸³ These physical impairments affect a person's everyday life and the activities that they participate in. Any problems with these physical abilities can lead one to feel poorly about themselves.

3.2.1 Designing for the Aging Body

Depending on where someone lives, each society cares for their elderly differently. In America, there are regulations for public spaces that require them to be accessible to everyone no matter their disability. The Americans with Disabilities Act (ADA) requires buildings to be barrier-free.⁸⁴ The development of physical impairments can be difficult for one's self-esteem. The inability to do things your body previously could can make one feel out of control of their own lives. In 1993 the Anchor Housing Association conducted a survey in London to assess what basic tasks elderly typically have a difficult time with. According to the survey, 49% of respondents have a difficult time going up and down the stairs. 44% have trouble taking a bath. 43% said that using

⁸³ Eckhard Feddersen, *Living for the Elderly a Design Manual*, (Basel : Boston : Birkhäuser, 2009), 13.

⁸⁴ Albert A. Peloquin, *Barrier-Free Residential Design* (New York : McGraw-Hill, 1993), Ix.

public transportation is difficult, 42% shopping, 40% doing housework, 22% washing clothes, 18% preparing and cooking meals, 17% getting in-and-out-of-bed, 15% moving around the house, and 15% said taking a shower was difficult.⁸⁵ These should be easy and simple tasks, but they can seem daunting to some elderly. Buildings are required to follow barrier-free (or universal) design. Residential homes are not under strict regulations, like healthcare facilities and commercial spaces. However, this lack of preparation in residential homes forces many, to have to make costly adjustments to their homes when they get older. The regulations or guidelines are in place to provide healthy, safe, and accessible spaces for everyone, no matter their physical disposition. “This does not mean that old age should be viewed as an illness, or that the impairments of ageing should be viewed either as irreversible or insurmountable. The aim of the designer should be to minimize the direct effects of impairments, to maximize safety and convenience, and to minimize the possible consequences of mishaps.”⁸⁶ Everyone develops impairments with different levels or severity and combinations. Some impairments can cause or amplify other impairments. Many facilities therefore design for all impairments. However, there are opinions that disagree with this philosophy on designing for the aging.

Even though barrier-free design allows for easier physical movement, there are some who claim that removing all barriers accelerates the deterioration of the physical body through its lack of use. An example of a facility that believes in this is the Yume No Mizumi Mura, elderly day care center in Chiba, Japan. At this facility, there are intentional barriers to challenge the occupants, both physically and mentally. Theoretically, the constant use of one’s muscles through the repetition of difficult physical activity would improve or maintain the body’s strength. The facility has various ramps and stairs for residents to move about the facility. “In the Mizumi village of a dream, it is a "barrier all" facility that deliberately arranges barriers that may be

⁸⁵David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 19.

⁸⁶ Ibid. 21.

encountered routinely, such as steps, slopes, and stairs.”⁸⁷ It promotes exercise through simple everyday tasks. Promoting movement and muscle stimulation is a great way to remain healthy. “The aim is to deliberately establish a barrier, master the way to overcome the barrier, and extend the range of living at home.”⁸⁸ (In chapter 4 section 1 of this dissertation, it explains the health benefits of physical activity.) Architecture can be used as a tool to promote movement in a safe and accessible way.

As mentioned in the previous section, the body develops different physical ailments. These changes in physical ability can make everyday activities much more difficult. Listed below are simple elements that can be included in the design to make such tasks easier through integrating elements from the barrier-free regulations with the “with-barrier” philosophy of the Yume No Mizumi Mura facility. These are aspects that need to be kept in mind when designing for the elderly.

3.2.1.1 Mobility Loss

Figure 4 Example Threshold Fasteners for Safer Access

Source: Albert A. Peloquin, *Barrier-Free Residential Design* (New York : McGraw-Hill, 1993), 17.

One of the most common ailments developed as one ages is mobility loss. Commonly experienced is having difficulty walking, and standing and walking up and down stairs or steps. It may also be difficult to bend and reach for items that are placed too high or too low. Many who have these impairments may have to use a walker, cane or wheelchair when walking long distances. To prevent this ailment from developing, one

⁸⁷“Characteristics of the Dream Mizumi Village.” Yume No Mizumi Mura, Google Translate, accessed December 2, 2016, <https://translate.google.com/translate?depth=1&hl=en&prev=search&rurl=translate.google.co.jp&sl=ja&u=http://www.yumenomizuumi.com/about/peculiarity-01.html>.

⁸⁸ Ibid.

should try to move as much as possible. One way to improve mobility is to reduce the number of trip hazards, such as the entrance threshold. The threshold height should be no more than ½” tall.⁸⁹ A ramp allows for an even smoother transition. Another design feature that can be integrated for mobility loss is handrails lining long corridors, and intermittently spaced seating to provide a place to take a break.⁹⁰

3.2.1.2 Strength and Fitness Loss

Mobility loss can be advanced further with strength and fitness loss. Individuals that experience strength and fitness loss may have difficulty walking long distances, lifting heavy objects, or have a feeling of tiredness after physical exertion. Walking long distances can make one feel out of breath. This type of physical ailment can be seen even in young adults with lack of regular physical activity. Those that are experiencing strength and fitness loss may prefer to use the elevator, ramps, or limit the amount of walking. Many will not participate in as many activities because of their fear of tiredness or overexertion. However, one can improve their strength through daily physical activity, such as walking or lifting weights. “The frail elderly who never walk at least one mile per week are 1.56 times more likely to decline in function...”⁹¹ While the typical barrier-free design would recommend limiting the walking distances and providing more elevators, one’s strength loss is an ailment that can typically be improved. Hence, providing residential environments that promote movement and muscle stimulation will help to prevent or recover strength and fitness loss. This stance is based on Yume No Mizumi Mura’s belief in building strength through the process of these activities.

3.2.1.3 Dexterity loss

Dexterity loss can cause many issues with simple daily activities. For example, they may have difficulty opening items like jars, doors, windows, and buttons on clothing. When designing spaces for elderly it is important to remember that these simple

⁸⁹ Albert A. Peloquin, *Barrier-Free Residential Design* (New York : McGraw-Hill, 1993), 15.

⁹⁰ David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 17.

⁹¹ Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL : Human Kinetics, 2005), 280.

tasks become extremely difficult. Therefore, one recommendation from the barrier-free design is to provide maximum control on doorknobs, switches and handles.⁹²

For example, round doorknobs are inefficient and can be difficult to open. A well-known recommendation is the lever-handle.⁹³ It is much easier to use than round doorknobs because they are easier to grasp and control. In addition, the weight of doors also can be considered a barrier for elderly. It is important for doors to have heavy-duty hinges to provide easy mobility.⁹⁴

Figure 5 Example Lever Handles

Source: Albert A. Peloquin, *Barrier-Free Residential Design* (New York : McGraw-Hill, 1993), 19.

3.2.1.4 Sense of Touch

Another issue is loss of sense of touch. Those that experience this may have difficulty sensing temperature through touch.⁹⁵ This impairment can be dangerous in the bathroom or kitchen. The inability to feel high temperatures may lead to accidental burning by touching a hot stove or hot water. One way to help prevent this type of accident is to install thermostatic controls on the water temperature. In addition, there is a new cooking appliance that cook's food through induction, or the transfer of energy through the magnetic field, which keeps the surface from getting as hot as a conventional stove.

⁹² David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 17.

⁹³ Albert A. Peloquin, *Barrier-Free Residential Design* (New York : McGraw-Hill, 1993), 16.

⁹⁴ *Ibid.* 16.

⁹⁵ David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 18.

3.2.1.5 Temperature Sensitivity

As we age our metabolic rate changes and can cause many to have a higher sensitivity to temperature variation.⁹⁶ This increased sensitivity to temperature variation can also be due to the inability to maintain body temperature. The loss of control over body temperature can lead to hypothermia or heat stroke. Thus, it is important to provide sufficient insulation and ventilation. A heating ventilation and air conditioning system with thermostat controls would help to keep the residents comfortable at the right temperature.

3.2.1.6 Breathing Issues

Another possible impairment is breathing difficulties. Our breathing ability can cause “shortness of breath, asthma, increased sensitivity to smoke: the inability of the lungs to take in sufficient air reduces the amount of oxygenated blood and makes physical activities more difficult and resting periods longer...”⁹⁷ Therefore it is important to design spaces that are easy to clean to remove dust. Typical barrier-free design recommends minimizing the distances for walking. Nevertheless, there is scientific proof that physical activity improves one’s breathing ability and it is important to exercise the lungs (Chapter 4.1 of this document.) This suggestion is similar to strength and fitness loss. Providing residential environments that promote movement and muscle stimulation helps prevent or recover breathing abilities. It is important, however, to provide rest stops and places where the elderly can sit if they need a break. Periodical benches, for example, would be sufficient. This stance, too, is based on Yume No Mizumi Mura’s belief in building strength through the process of these activities.

3.2.1.7 Incontinence

As adults age and develop impairments, many of them become embarrassed of this issue: incontinence.⁹⁸ Many take the ability to control their bladders and bowels for granted. As individuals age, the ability to control these urges may be reduced, which can

⁹⁶ Ibid. 18.

⁹⁷ David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 17.

⁹⁸ Ibid. 18.

cause anxiety and apprehension to participate in activities. Whether it is a public or private space, conveniently located bathrooms help ease their anxiety and promote more participation in various activities.

3.2.1.8 Eyesight

We rely on our eyesight for 90% of the environmental data we learn every day. “Older people may suffer from partial sightedness, short sightedness, long sightedness, blurred vision, or possibly total blindness; they experience a diminishing visual field, a reduced ability to see detail and adjust focus, and reduced lens transmission.”⁹⁹ These issues with vision can reduce mobility. They can also lead to tripping, falling, and the reduction in the number of activities elderly participate in. One way to promote environments that are easier on the eye is through proper lighting controls, and using contrasting colors to show differentiation in elements. Color can make a large difference in the atmosphere of a room:

“Warm and luminous colors with high levels of light produce a centrifugal action, directing attention outward, toward the environment. Such environments are conducive to cheerfulness and activity. Softer surroundings, cooler colors, and lower levels of illumination produce centripetal action. Such environments encourage inward orientation and enhance the ability to concentrate.”¹⁰⁰

It is important to remember that although colors with similar hues unify and enlarge a room, they can become difficult to distinguish when one has poor eyesight. Providing enough contrast between the walls and furnishings when designing a space will help the furniture stand out.¹⁰¹

3.2.1.9 Hearing loss

We also heavily rely on hearing for most of our daily communication. Partial or total hearing loss can cause difficulty communicating with others. Having difficulty

⁹⁹ Ibid. 18.

¹⁰⁰ Frank H. Mahnke, *Color, Environment, and Human Response : An Interdisciplinary Understanding of Color and Its Use as a Beneficial Element in the Design of the Architectural Environment*, Color, Environment & Human Response (New York : Van Nostrand Reinhold, 1996): 71.

¹⁰¹ Ibid. 86.

communicating with others can lead to one feeling lonely and isolated.¹⁰² Elderly can develop hearing loss of certain frequencies and lead to sensitivity to ‘extraneous noise.’¹⁰³ Architecturally, it is important to provide sufficient sound insulation between units in the walls, floors, and ceilings. It is also important to provide a visual emergency alarm system.

3.2.1.10 Sense of Smell

Loss of sense of smell can lead to loss of appetite. This can greatly affect one’s health. If one does not eat enough nutritious food, then they can become weak. Loss of smell can also be a safety issue. The lack of ability to smell can reduce one’s ability to detect fire.¹⁰⁴ Similar to hearing loss, it is important to provide a visual emergency detection.

3.2.1.11 Nutrition

We rely on food to nurture and power our bodies. Therefore, digestive issues can lead to many other health issues, such as loss of appetite, weight loss, diabetes, restrictive diet, dry mouth, and difficulty chewing. Architecture is typically separate from food and nutrition. However, the movement of integrating plants onto the exterior and into the interior of buildings is bridging this gap. Vertical farming is an alternative form of farming that allows for controlled environments. An example of an experimental vertical farming is the Pasona Group in Otemachi, Tokyo. It is the largest farm-to-table system in an office building in Japan.¹⁰⁵ Within the building there is 43,000 square feet of greenery, and 200 species of fruits, vegetables and rice.

“Using both aquaponics and soil based farming, crops and office workers share a common space. For example, tomato vines are suspended above conference tables, lemon and passion fruit trees are used as partitions for meeting spaces,

¹⁰² David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 18.

¹⁰³ Ibid. 18.

¹⁰⁴ David G. Robson, *Homes for the Third Age: A Design Guide for Extra Care Sheltered Housing*, (London: E & FN Spon, 1997), 18.

¹⁰⁵ “Urban Farm at Pasona Tokyo Headquarters,” Kono Designs, accessed December 3, 2016, <http://konodesigns.com/portfolio/Urban-Farm/>.

salad leaves are grown inside seminar rooms and bean sprouts are grown under benches. The main lobby also features a rice paddy and a broccoli field.”¹⁰⁶

Through technology, such as HEFL, florescent lights, climate control systems, LED lamps, and automatic irrigation systems, plants are now able to grow indoors. While this example is a large-scale project, the systems can be simplified and applied at a smaller scaled. Since many people spend most of their time indoors bringing nature into the building provides a physical connection to nature. Thus a closer connection to nature promotes better and healthier nutrition because of the knowledge of where one’s food comes from.

Figure 6 Urban Farm at Pasona Tokyo Headquarters

Source: Urban Farm at Pasona Tokyo Headquarters,” Kono Designs, accessed December 3, 2016, <http://konodesigns.com/portfolio/Urban-Farm/>.

3.3 Mental Health

Everyone’s mental capabilities vary significantly and are affected by their lifestyles. As one ages, the cognitive changes that occur can vary greatly as well. There are many ways and activities in which someone can prevent cognitive aging.

An individual’s physical and mental health plays an important role in their sense of well-being. Well-being can only be determined through asking the subjects about their life satisfaction. As people age, many fear aging, poverty, becoming a burden to their family and friends, change or uncertainty, insanity, losing freedom, identity and dignity, abuse, or death.¹⁰⁷ Many elderly individuals that have these fears also have issues with their self-image. An individual’s self-esteem correlates with the deterioration of physical bodily functions. If a person is unable to do tasks that were once simple and easy, then it can negatively affect their self-esteem and mental health. In addition, elderly individuals can develop anxiety and become unsure of themselves, and reduce their social

¹⁰⁶ Ibid.

¹⁰⁷ Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL: Human Kinetics, 2005), 236.

interactions and willingness to try new things. “An individual’s perception of overall health and function also affects participation in physical activities. If an individual perceives his health and function as poor, then he is less likely to participate in activities.”¹⁰⁸

Another issue that affects one’s mental health is lack of social support from friends and family—due to death or moving away—which can cause the elderly to feel isolated and lonely. When children and grandchildren move away, elderly are no longer needed and have nothing to nurture. Retirement, too, can lead to a feeling of loss of identity, financial stability, and independence. As physical health deteriorates many elderly individuals experience anxiety from changing their living arrangements.¹⁰⁹ These negative possibilities can decrease their sense of well-being and lead to depression in the elderly.

Depression, especially, needs to be taken seriously since it can sometimes impair one’s life more than medical illness. It is commonly caused by the development of illnesses or “psychosocial factors, such as the death of a spouse, retirement, social isolation and diminished income.”¹¹⁰ In a study published in the *Annals of Family Medicine* that examined 1801 patients 60 years and older with depression, it found that “As depression severity increased, quality of life and physical and mental functioning declined, while disability increased,’ the authors write, commenting that depression has a ‘devastating impact. on both emotional and physical functioning in older adults.”¹¹¹ The issues listed in the previous paragraph are some of the well-known reasons for depression in the elderly. Another reason for depression in the elderly is societal values.

“Such stereotypes reflect the social structure and age stratification system in a society that places a high value on independence and achievement; they also reflect a fear of problems presumed to be associated with aging. Steib indicates

¹⁰⁸ Scott D. McPhee, Timothy R. Johnson, and Mary S. Dietrich, "Comparing Health Status with Healthy Habits in Elderly Assisted-Living Residents," *Family and Community Health* 27, no. 2 (2004): 6.

¹⁰⁹Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL: Human Kinetics, 2005), 237.

¹¹⁰ Janice Hopkins Tanne, "Depression Affects Elderly People's Lives More Than Physical Illnesses," *British Medical Journal* 329, no. 7478 (2004):1307.

¹¹¹ *Ibid.* 1307.

that ‘old age is not valued highly because it is associated widely with decline in physical attractiveness, vigor, health condition, sexual prowess, and perhaps some mental abilities. And ... it is associated with the expectation of fewer years of life itself.’¹¹²

Society’s image of aging can cause the ‘older age’ population to feel negatively about themselves. Many older adults refuse to identify themselves as elderly. “For example, found that self-identification as old was associated with lower life satisfaction, even after the researchers controlled for objective conditions such as health, social class, marital status, retirement and social activity.”¹¹³ This negative self-image is detrimental to their mental health and can contribute to depression. Old age should be celebrated—it is a part of every living being’s lives. Older adults are rich with knowledge and experience and add value to our society. Even though categorization has led many elderly individuals to feel negatively about themselves, it helps provide the right care and facilities to meet the needs of the common mental and physical ailments that one typically develops as they age.

3.4 Designing for the Aging Mind

3.4.1 Habit

Housing, particularly, is so important for the elderly. Elderly individuals become extra reliant on their environment and develop an emotional and habitual connection to their homes. When these developed habits are broken, they can experience emotional distress. Our lives are composed of various habits, from waking up and brushing our teeth, to sitting reading the newspaper while drinking coffee. These habits are formed to relieve our minds from the constant need to make decisions. Many do not realize these formed habits cause an attachment to the environment in which they are formed. As mentioned above, moving residences can cause anxiety and depression. It is through the formation of habits that we become comfortable with our environment. When these habits are broken, anxiety and depression can arise. There are different ways in which we

¹¹² Russell A. Ward, *The Environment for Aging : Interpersonal, Social, and Spatial Contexts*, (Tuscaloosa: University of Alabama Press, 1988): 12.

¹¹³¹¹³ Ibid. 12.

can analyze our relationship with space: house (objective space), home (emotional space) and dwelling (comfortable space.)¹¹⁴ While everyday activities seem inconsequential, they become an important part of our lives, as explained in *Living for the Elderly: A Design Manual*,

“So although not a distinct activity in itself, the act of living can be regarded as a succession of many individual actions. These are by no means trivial things: a large part of our lives consist of ritualized activities, for example cooking, eating, washing, sleeping and clearing up. Through their regular repetition, consistent pattern and our own recurring gestures, we internalize them physically until they happen “of their own accord” without us having to think about them. The repetition and regularity with which we do things becomes habit and creates a feeling of dependability and security and not least relieves us of the need to continually make new decisions.”¹¹⁵

The formation of habits causes people to become attached to their environments or homes. The issue with moving homes is not because of the different spatial arrangement, it is more so the breaking of old patterns and needing to develop new ones.¹¹⁶ “Living is an interactive process between the inhabitant(s) and the room. This interdependency is indissoluble; as I shape the space I live in, so too do I form myself, and vice versa.”¹¹⁷ The longer we spend in a space, the harder it is to break these habits. Therefore, as people age, it becomes very difficult and traumatizing to change environments. For the elderly, especially, attachment to place is a way of keeping the past alive, a way of strengthening positive self-image and portrayal of competence and independence.¹¹⁸ The idea of a home is connected to the duality of private versus public. It is the ability to keep unwanted people out of a personal environment. The home evokes

¹¹⁴ Antonio Cristoforetti, Francesca Gennai, and Giulia Rodeschini, "Home Sweet Home: The Emotional Construction of Places," *Journal of Aging Studies* 25, no. 3 (2011): 225.

¹¹⁵ Eckhard Feddersen, *Living for the Elderly a Design Manual*, (Basel : Boston : Birkhäuser, 2009), 39.

¹¹⁶ *Ibid.* 39.

¹¹⁷ *Ibid.* 39.

¹¹⁸ Antonio Cristoforetti, Francesca Gennai, and Giulia Rodeschini, "Home Sweet Home: The Emotional Construction of Places," *Journal of Aging Studies* 25, no. 3 (2011): 226.

a sense of relaxation, freedom, security, privacy and identity.¹¹⁹ As they age and develop physical and mental impairments, many older adults feel more vulnerable in public spaces. The home provides a refuge and safe haven from this feeling of vulnerability. A person's home becomes a part of their identity and is expressed through the personalization of their space. The items, materials, and organization all help the person define and represent who they are. This is why many are embarrassed when a friend comes over to your house and it is messy. We may feel that the visitor thinks that since the home is messy, we are therefore unorganized and dirty. "In the case of elderly people they perform the particularly significant function of 'summing up their lives, linking them to the person they once were, as well as embodying memories of a lost partner.'¹²⁰ As we age, our lives and circumstances change and people come and go, therefore, the ways in which we experience the home changes. For example, for widows, 'heart displacement' occurs. When the spouse is still alive, the center of the house concurs with the heart, the gathering of family, such as the kitchen. After the spouse's passing, the meaning of the kitchen changes from the 'heart' to 'coordination center.'¹²¹ The kitchen no longer functions as a social gathering space, but merely functions as a place to cook and eat their meals.

Many current homes are not designed to adapt to the changing circumstances of life and needs of the elderly as they age, which consequently causes many to move to more appropriate living arrangements (despite most wanting to remain in their homes.)

The development of physical and mental impairments requires home modifications for the house to meet their changing needs. This need for flexibility of the environment is supported by the Lawton and Simon's environmental docility hypothesis.

"The reduced physical and cognitive competence associated with aging cause behavior to become more dependent on environmental forces at the very time when the aged are less able to manipulate the environment. In effect, the elderly

¹¹⁹ Ibid. 225.

¹²⁰ Ibid. 226.

¹²¹ Antonio Cristoforetti, Francesca Gennai, and Giulia Rodeschini, "Home Sweet Home: The Emotional Construction of Places," *Journal of Aging Studies* 25, no. 3 (2011): 228.

become ‘prisoners of space.’ This local dependence can place them at a disadvantage, because the range of modern support networks has expanded beyond localized neighborhoods. The reduced mobility of some older people and the tendency of many likely to ‘rely on the local area and its inhabitants to support their needs, while most of today’s society reach far from home to meet the needs of everyday life.’¹²²

Since the individuals are no longer able to adapt their behavior, the environments must be flexible and adjust to the changing needs of the users. The development of mobility, sight and balance issues contribute to the reasons why many current homes are unsuitable for the elderly. The three most hazardous areas in a home are: the outside steps to a home, the stairway to an additional floor, and bathrooms. By making adjustments to the home, the risk of falling is significantly reduced. “According to Rubenstein (1999), between 35% and 45% of falls are attributed to home hazards such as inadequate bathroom grab rails and stairway railings, poor lighting, clutter on the floor, exposed electrical cords, and loose throw rugs.”¹²³ The factors that most apply to the risk of falling are, gait and balance impairments, muscle weakness, transfer difficulties, number and type of medications, cardiovascular risk factors, and environmental hazards in the home.¹²⁴ Because of these physical impairments, such as mobility loss, older adults can create ‘spot locations.’¹²⁵ These are places that have everything they need for daily activity at hand such as: “telephone, cellphone, TV remote control, switches, clocks, books, creams, etc.”¹²⁶ These ‘spot locations’ can provide a sense of security and control because elderly are able to control many things and visually see their space from one location. Despite the issues that the elderly may have with the physical environment of their homes, it is important to be within their home because,

¹²² Russell A. Ward, *The Environment for Aging : Interpersonal, Social, and Spatial Contexts*, (Tuscaloosa: University of Alabama Press, 1998), 3.

¹²³ Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL: Human Kinetics, 2005), 153.

¹²⁴ *Ibid.* 153.

¹²⁵ Antonio Cristoforetti, Francesca Gennai, and Giulia Rodeschini, "Home Sweet Home: The Emotional Construction of Places," *Journal of Aging Studies* 25, no. 3 (2011): 228.

¹²⁶ *Ibid.* 228.

“it brought feelings of control and anchorage to their lives. Within the imbalance of frailty, participants needed to accommodate the physical and social changes necessary to continue to ‘be’ at home, but equally needed to work to regain or reconfigure what it meant for them to ‘feel’ at home. Being at home was more than occupying a physically familiar space, it was also an anchorage to previously frequently habituated places.”¹²⁷

3.4.2 Memory

Memory becomes an important factor in older adult’s lives. Many spend a significant amount of time reflecting on the past and reliving memories through pictures and items they have collected over time. “The objects with symbolic value (jewels, ceramics, and paintings), articles for self-expression (musical instruments, paintings, and artistic materials of various kinds), consumption articles (objects of entertainment like a television, a radio and books), and photographs, the most frequent category.”¹²⁸ Our identity needs support and therefore people accumulate items to help define themselves. The displayed items reflect one’s emotions and allows the occupant to share their feelings with visitors. The objects become imperative to their self-image, especially during large life changes, like widowhood. “Such objects, in fact, often assume the role of transitional objects, and they are distinguished by their ability to ensure a sense of identity for the elderly person and to furnish ontological security.”¹²⁹ These items can also be found in the bedroom, the most intimate space of the house. According to interviews conducted in Northern Italy of widows about their homes, the bedroom is the place where the widows meditate on the past, nostalgic and often melancholy.¹³⁰ It is the space in which they shared intimate memories with their late husbands. The living room is considered the show room and the bedroom is a more private extension of that. Even though these interviews were of widowed women, the emotional construct of the bedroom and home

¹²⁷ Nicholson et al., "Living on the Margin: Understanding the Experience of Living and Dying with Frailty in Old Age," *Social Science & Medicine* 75, no. 8 (2012): 6.

¹²⁸ Antonio Cristoforetti, Francesca Gennai, and Giulia Rodeschini, "Home Sweet Home: The Emotional Construction of Places," *Journal of Aging Studies* 25, no. 3 (2011): 229.

¹²⁹ *Ibid.* 229.

¹³⁰ *Ibid.* 229.

apply universally. The emotional aspects, however, are amplified due to the loss of their husbands.

Intermediary spaces also become important, such as a window, terrace, garden, or bench outside. This space brings the outdoors indoors. This space can become an important place for gardening and plant activity. One of the women participating in a study done to understand the meaning of place in northern Italy mentioned that gardening on her balcony has taken on more of a care-giving act. She displays mother-like qualities towards the plants and flowers that she grows. Whether they were just cut flowers or potted plants, caring for plants was one aspect of the house that provided some relief from loneliness. While here in Hawai'i there are no significant changes in the seasons, the natural physical environment around, typically viewed through the window, play a substantial role in lives of elderly. "The interviewees very frequently described the view from the windows of their homes as crucial: the presence or absence of a view of the mountains or other natural landscapes, in fact, performed a key role in their psychological well-being because it influenced their moods."¹³¹ The plants become one of the items that the widowers identify themselves and their daily activities with. Windows are a connection to the outside world for those who have a difficult time moving. For example, in a study done in the UK on what is like to be frail in old age, a woman mentioned that the streetlight outside her home is very important to her. "For months I had no streetlight here but my daughter faxed all my Councillors and at last, the Council came and put it up, I don't like it [the style] but still I've got a light and so I know I can see again and they can see me."¹³² While most people would feel that the light is a nuisance, or the open window is letting people see into one's private life, it is in a sense, a form of security for Flora, age 87. She finds comfort that she has light and people can see her.¹³³ The study listed above explains the importance of memorabilia as one ages, but many begin to reduce the number of items they own and possibly the size of the house to reduce the amount of physical labor to clean and care for the home.

¹³¹ Antonio Cristoforetti, Francesca Gennai, and Giulia Rodeschini, "Home Sweet Home: The Emotional Construction of Places," *Journal of Aging Studies* 25, no. 3 (2011):231.

¹³² Nicholson et al., "Living on the Margin: Understanding the Experience of Living and Dying with Frailty in Old Age," *Social Science & Medicine* 75, no. 8 (2012): 4.

¹³³ *Ibid.* 4.

4 Chapter 4: Therapeutic Activities to Promote Healthy Lifestyles for Housing

Living a healthy lifestyle is the main way in which one can age healthily. Eating a nutritious diet, exercising daily, stimulating the mind, getting enough rest and finding a form of stress relief are all common knowledge and recommended. There are many scientific studies that prove that these activities and ways of life will most likely benefit your health. However, today we have access to a large variety of unhealthy food and technology that hinder many people from practicing these therapeutic activities.

Architecture can play a key role in promoting these healthy habits. For example, the design and layout of a building can promote more physical activity by the use of long ramps, shaded pathways and open spaces for group activities with interesting visual elements to look at along the path. Including interesting visual features along the path make the walk more pleasurable and less of a chore. This research will focus on three proven ways to improve one's wellbeing and postpone or prevent the development of ailments that typically accompany aging: physical activity, socialization, and horticultural therapy. Each section will explain the basic elements, scientific proof of benefits, and how to promote these activities through architecture.

4.1 Physical Activity

Physical activity is one of the most well-known preventative activities someone can do to prevent mental and physical deterioration. There is an abundant amount of evidence to support that physical activity reduces the risk of a “stroke, hypertension, type 2 diabetes, osteoporosis, and a variety of cancers including colon and breast cancer.”¹³⁴ There have been many studies that recognize the reduction of falls and overall physical functioning improvement through regular physical activity. “The interventions have, however, resulted in significant improvements in overall function of the exercise groups. For example, a number of researchers focusing on resistance exercise training have reported significant improvements in physical function (e.g., improved sit-to-stand

¹³⁴ Institute of Medicine . Committee on the Public Health Dimensions of Cognitive Aging, *Cognitive Aging: Progress in Understanding and Opportunities for Action*, (Washington, D.C.: The National Academies Press, 2015): 114-115.

performance, increase in absolute strength) or mobility (e.g., change in ambulation status, improved gait speed.)”¹³⁵ Besides just physical improvements, many physicians recommend exercise as a form of therapy for depression. “Low-intensity exercise and exercise that elicits an increase in VO₂ max are equally effective in lessening depressive symptoms. Evidence has shown that exercise is as effective as psychotherapy and antidepressant therapy in treating mild-to-moderate depression, and even more effective when used in conjunction with the conventional therapies.”¹³⁶ It is important for older adults to not just assume that when they get old their physically active lives are over. When someone has this expectation of inactivity then, that is what they will have.

“A vicious cycle develops. As people age, they become less active. The less active they are, the less physical ability and endurance they have. The less physical ability they have, the less inclined they are to be physically active. And the less active they are, the more physical capacity they lose. The less they move, the less they can move. They begin to feel old and act old, which includes not being physically active.”¹³⁷

In order to prevent this cycle, older adults must not stop moving and exercising. While architectural design may not have a large impact, it can be used to promote more movement in everyday activities.

An example of a facility that promotes physical and mental activity through the layout and design is an elderly day care facility called Yume No Mizumi Mura. It is in Tokyo,



Figure 7 Image of Stairs in Yume No Mizumi Mura

Source: Author’s Photograph

¹³⁵ Waneen Wyrick Spirduso, *Physical Dimensions of Aging*, (Champaign, IL: Human Kinetics, 2005), 152.

¹³⁶ Ibid. 242.

¹³⁷ Ibid. 284.

Japan and takes an unconventional take on facility design for the elderly. This facility has a unique theory that it is better for you to do something yourself, then someone doing it for you. Typically, in many elderly care facilities, the design is based on universal design, or barrier free. This is to make the facility more accessible and hopefully to reduce accidents, such as falling or tripping. However, Yume No Mizumi Mura has intentional barriers such as long ramps, stairs, and various activities that stimulate one's minds and bodies.¹³⁸ By constantly having to do these activities, it allows for residents to stay active and healthier longer. If both the muscles of the mind and body are not used, then they tend to atrophy and the individual will become weaker than before. This is why this facility has its members work for rewards through physical activity and games to stimulate the brain. The facility incorporating these intentional barriers is successful because it has attendants around the clock to help members. In an individual home, barriers such as stairs and the change in the floor height can be dangerous for frail elderly individuals. It is difficult to determine which method is best. Ultimately it depends on the individual. Architecture that challenges an aging body to move is beneficial, but architecture such as small step-ups, small doorways and slippery floor materials can be dangerous as one ages. There is a balance between the two that needs to be met through meticulous design.

4.2 Socialization

In Hawai'i and in societies across the globe, elderly whom live alone are at risk of social isolation and loniless. Many who age suffer from mobility loss, which reduces the amount of activities that one participates in. "Loneliness can be defined as the emotional state caused by unfulfilled social and intimacy needs."¹³⁹ The concept of loneliness is

¹³⁸ "Characteristics of the Dream Mizumi Village." Google Translate: Yume No Mizumi Mura, accessed December 2, 2016, <https://translate.google.com/translate?depth=1&hl=en&prev=search&rurl=translate.google.co.jp&sl=ja&u=http://www.yumenomizuumi.com/about/peculiarity-01.html>.

¹³⁹ Institute of Medicine . Committee on the Public Health Dimensions of Cognitive Aging, *Cognitive Aging: Progress in Understanding and Opportunities for Action*, (Washington, D.C.: The National Academies Press, 2015): 121.

distinct from being alone, or social isolation, which is usually defined as living alone, not having a partner, and having few social supports.”¹⁴⁰ Loneliness has been connected with

“(1) stress and activation of the hypothalamic-pituitary-adrenal axis with possible increased inflammatory responses in the brain; (2) less neuroplasticity in those older individuals who lack interaction with others, resulting in less ability to compensate for age-related neurodegenerative changes; (3) lower cognitive stimulation because of social isolation; (4) increased cognitive demand due to chronic surveillance for and protection from threats; (5) increased depression and decreased physical activity; (6) reduced quality and quantity of social interactions; and (7) diminished sleep quality resulting in impaired learning.”¹⁴¹

While loneliness and social isolation are different issues, they are related in that sometimes social isolation can amplify loneliness.

Hawai’i does not have many options for public transportation, therefore most people are reliant on vehicles. “The physical environment of many cities in the United States presents barriers to elder health, well-being, and the ability to age in place. These include community design that separates residential and commercial areas, the absence of adequate alternative transportation services, and limited accessible housing.”¹⁴² Many elderly are no longer able to drive because of mobility loss, visual impairments, hearing impairments or slowed reaction time. These factors can make driving very dangerous. Consequently, many elderly are stranded in their homes alone. Compared to older adults who drive, those, who no longer drive, make 15% less trips for medical appointments and 65% less trips for religious, social or community activities.¹⁴³ That is a significant percentage less and plays a large impact on their well-being. The automobile has also caused the network for everyday services to expand far past the walkable neighborhood. They become reliant on their ‘social worlds’ that they maintain through television,

¹⁴⁰ Institute of Medicine . Committee on the Public Health Dimensions of Cognitive Aging, *Cognitive Aging: Progress in Understanding and Opportunities for Action*, (Washington, D.C.: The National Academies Press, 2015): 134.

¹⁴¹Ibid. 134.

¹⁴² Amanda J. Lehning, "City Governments and Aging in Place: Community Design, Transportation and Housing Innovation Adoption," *The Gerontologist* 52, no. 3 (2012): 1.

¹⁴³ Ibid. 2.

phones, letters or magazines.¹⁴⁴ Their social support consists of family members, friends and neighbors. Many are reliant on family members for care assistance, but their interactions with friends seem to be most beneficial for well-being. Socialization with one's spouse, adult children or friends can affect one's health. The frequency that elderly spend time with their friends is more significant than time with family. It can affect their well-being and morale. "For example, a number of studies have found no relationship between morale and the frequency of interaction of elderly persons with their children. Further...found no relationship between the morale of elderly persons and their exchange of aid with children. Several studies have observed positive effects of interaction frequency with other kin, including other siblings and grandchildren."¹⁴⁵

The benefits of social interaction can be difficult to determine because socializing typically involves some other form of activity. This, however, can be beneficial either way for elderly because even if it is not just specially the socialization that is improving their well-being, socialization still helps to get them involved in activities. Social interaction can actually also have negative affects. These are interactions that cause stress. "For example, a study of grandparenting by postmenopausal women found that working memory and processing speed were positively associated with spending time with grandchildren one day per week, while poorer cognition was associated with minding grandchildren several days per week, a situation that prompted differences in association between social engagement and cognitive aging."¹⁴⁶ This distinction between positive and negative social encounters can be addressed architecturally through provision of both private and public space. The proposed accessory dwelling unit being a separate entity provides the necessary privacy when they would like to retreat, however in the community living site, it is necessary to have areas for social interaction that also promote other activities. These can be simple shaded chairs and tables in a lush

¹⁴⁴ Russell A. Ward, *The Environment for Aging : Interpersonal, Social, and Spatial Contexts*, (Tuscaloosa: University of Alabama Press, 1988), 5.

¹⁴⁵ Alfred Dean, Bohdan Kolody, and Patricia Wood, "Effects of Social Support from Various Sources on Depression in Elderly Persons," *Journal of Health and Social Behavior* 31, no. 2 (1990): 148.

¹⁴⁶ Institute of Medicine . Committee on the Public Health Dimensions of Cognitive Aging, *Cognitive Aging: Progress in Understanding and Opportunities for Action*, (Washington, D.C.: The National Academies Press, 2015): 135.

courtyard, a grassy lawn for excersie classes, a community room for activities such as pottery, arts and crafts, and cooking. Utilizing socializing as a tool for the elderly to be involved in activities can reap benefits for their well-being.

4.3 Biophilia and Horticultural Therapy

“Biophilia refers to humans’ inherent affinity for the natural world, which is revealed in nine basic environmental values.”¹⁴⁷ These are according to the author Stephen Kellert of *Building for Life: Designing and Understanding the Human-Nature Connection*. They are as listed:

“Aesthetic, or the physical appeal of and attraction to nature; dominionistic, or mastery and control of nature; humanistic, or emotional attachment to nature; moralistic, or moral and spiritual relation to nature; naturalistic, or direct contact with and experience of nature; negativistic, or fear of and aversion to nature; scientific, or study and empirical observation of nature; symbolic, or nature as a source of metaphorical and communicative though; and utilitarian, or nature as a source of physical and material benefit.”¹⁴⁸

These environmental values are how a person derives meaning from nature. The values are imperative to the physical, material, emotional, intellectual and moral well-being. Kellert argues that it is only through learning and experiencing that one can cultivate the benefits of exposure to nature. An example, of cultivating the knowledge required to reap the benefits of nature is horticultural therapy.

“Horticultural therapy (HT) is defined as a process through which plants, gardening activities, and the innate closeness we all feel toward nature, are used as vehicles in professionally conducted programs of therapy and rehabilitation.”¹⁴⁹ The therapy has three components: environment with or without greenery, plants, the process

¹⁴⁷ Stephen R. Kellert, *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings for Life* (Hoboken, N.J.: John Wiley & Sons, 2005): 3-4.

¹⁴⁸ Ibid. 34.

¹⁴⁹Masahiro Toyoda, “Horticultural Therapy in Japan- History, Education, Character, Assessment,” *JAD no. 2* (2012): 52.

of perception and cultivation, and people, the vehicles for therapy. It is a possible way to reduce the cost of health care.

It is vital to stimulate the five senses, through color, shape, smell, touch and taste. By viewing and surrounding oneself with nature, there is a reduction in blood pressure, muscle tension, and skin conductance.¹⁵⁰ It is vital to choose plants according to the user's interests. The plants must elicit client's interests, provoke memories, give a sense of the four seasons, and use annual flowers and vegetables, and typically plants that grow fast, for users to have visible accomplishment. Visible accomplishment is achieved by using goal-oriented activities. These decisions are made based on reward. For example, germination leads to flowering and then fruition. There is no need for words, because it is visually communicated.

Horticultural therapy is not new; it has been around for a long time. People have been practicing it on their own in their gardens or guided by a therapist in a group setting. This type of therapy was first recorded in Egypt. The mentally disabled royalty were given instructions to take walks through the palace gardens. In the 1800s, horticultural therapy was used for the mentally disabled, disadvantaged young people and mentally handicapped children after WWII in the United States. In 1951, occupational therapists used horticultural therapy in the hospital's geriatric ward.¹⁵¹

In Japan, horticultural therapy was first used in psychiatric hospitals during the 1900s. In the 1960s, it was used to treat tuberculosis patients. The current type of horticultural therapy that is used today was brought to Japan by three women from the United States in the 1990s. Setsuko Grosse, Yumiko Kan and Midori Sawada began to give and teach horticultural therapy through various organizations that they started.

After the bubble economy burst in the 1990s, many Japanese switched from material affluence to spiritual richness. In Osaka in 1990, the International Garden and Greenery Exposition started a big boom for gardening and introduced European herbs

¹⁵⁰ Masahiro Toyoda, "Horticultural Therapy in Japan- History, Education, Character, Assessment," *JAD no. 2* (2012): 56.

¹⁵¹ *Ibid.* 52.

and English gardens to the Japanese. Many forty to fifty-year-old people took great interest in gardening and horticultural therapy. Unlike in the United States, the therapy spread through its citizens, not medical staff.

4.3.1 Effects:

There are many positive psychological effects of horticultural therapy. It improves language, perception, cognitive functions, emotion, memory, energy and/or drive functions, attention functions and stress reduction, boost in self-confidence, recovery of self-affirmation, mental stimulation, and preservation or recovery of mental functions orientation functions (time, place, and person.)¹⁵². The social effects that occur are: prevention of disuse syndrome of body functions, reduction in sensation of pain, improvement/ preservation of body functions for activities such as learning, and execution of a task or communication.¹⁵³

The stress can be measured in various ways, but one that is not invasive is testing markers in saliva. Besides the many psychological benefits behind this therapy, there are also physiological benefits. It can improve hearing, taste, smell, prevent disuse syndrome, touch, temperature senses, cardiovascular functions, immunological functions, reduction in pain and improvement in self-care.¹⁵⁴

4.3.1.1 Examples of Benefits:

The article “Nature’s Long-term Benefits,” explains the long-term health benefits of interaction with nature or activity out in nature. In 1992 a study was conducted in Tokyo, Japan, asking residents ranging in age from 74-89, why some live longer than others.¹⁵⁵ The participants were contacted again five years later to see who was living. For those that lived near parks and green spaces, they had a much higher possibility of being alive after five years. “But being outside is a major pleasure, and being in nature is a powerful thing. It’s in our roots. It’s essential for our sleep, our mood, our health. It’s

¹⁵² Masahiro Toyoda, “Horticultural Therapy in Japan- History, Education, Character, Assessment,” *JAD no. 2* (2012): 58.

¹⁵³ *Ibid.* 58.

¹⁵⁴ *Ibid.* 58.

¹⁵⁵ John Carey, “Nature’s Long-term Benefits,” *National Wildlife (World Edition)* 51(2013): 12-13.

the ultimate pleasure of being connected to the Earth.”¹⁵⁶ Humans evolved in nature, therefore most people are drawn to it. For elderly with mobility issues, it can be difficult to gain easy access to nature. However, “they need to be out among green, growing things, around animals and around children-- all things usually banned from nursing homes.’ Gardens can be especially important. ‘One of the chief needs of a human being is to be needed,’ Duxbury says. Meeting that need for the old and infirm is a challenge, but ‘one way to do it is gardening and taking care of plants.’¹⁵⁷ The elderly’s need for being needed can be met through the integration of plants that rely on them to live. The article “The Impact of Live in Animals and Plants on Nursing Home Residents: A longitudinal Investigation,” provides more quantitative based information about the health benefits of a connection to nature.

An experiment similar to the Eden Alternative Model is called the, “Living Habitat.” The experiment introduces plants and various animals into the everyday system of the nursing care facility. Plants were integrated into the bedrooms and lobby of the space, and animals such as birds, two cats, and a dog were introduced to the nursing home for six months. After those six months were complete, a qualitative analysis of the residents’ feelings was taken. Those that had a high cognitive status as well as an affinity towards pets increased their positive interaction with their environment.¹⁵⁸ Another article supporting healthcare buildings with nature integrated is “Health Benefits of a View of Nature through the Window.”

This article examines the findings from an experiment that tested the health benefits of having a view into nature from a residential rehabilitation room. The site for the experiment is in a village, Roros, in the mountains of Norway. The building has modern architecture, large windows, and uses natural materials such as wood and stone. The public spaces have window views of the surrounding buildings, grass and trees. The private rooms have views of the valley and the mountains. Although some private rooms have their views of the mountains partially or completely blocked. The study looked at

¹⁵⁶ John Carey, “Nature’s Long-term Benefits,” *National Wildlife (World Edition)* 51(2013): 12.

¹⁵⁷ Ibid. 12.

¹⁵⁸ Katy Rudckdeschel and Kimberly Van Haitsma, “The Impact of Live-in Animals and Plants on Nursing Home Residents: A Pilot Longitudinal Investigation,” *Alzheimer’s Care Quarterly* (2001): 21.

250 lung and 345 heart patients. The overall results found that, “For women, a blocked view appeared to negatively influence change in physical health, whereas for men, a blocked view appeared to negatively influence change in mental health.”¹⁵⁹ The conclusion from the experiment was, “An unobstructed bedroom view to natural surroundings appears to have better supported improvement in self-reported physical and mental health during a residential rehabilitation programme, although the degree of change varied with gender and diagnostic group.”¹⁶⁰

An alternative take of “viewing nature through a window,” can be found in the book, *Biophilic Design* by Stephen Kellert. It gives examples of why just a mere window is not necessarily beneficial. The obvious protection from weather, by using glass is a great success, but “through glass, we observe the world outside comfortably and safely and without the challenges of actual engagement”¹⁶¹ This lack of engagement can only reap limited benefits, which is why it is important to create spaces that promote interaction outdoors with plants. The act of gardening engages the participant and stimulates their minds.

During my time in Japan, from January to May 2016, I had the privilege to visit a facility called Kyodo-sha, which is geared to help the mentally disabled. The facility provides a place for the mentally disabled to come during the day and participate in various activities. The facility offers a gardening and horticulture program, baking program, and a pottery program. All of the plants, bread, and pottery are then sold to provide money to run the facility. The facility is coupled with various group homes nearby that give the mentally disabled residents a place to live. Besides providing a place for the mentally disabled, the facility is used by a non-profit organization called the Japan Horticultural Therapy Society. It was established in 1995 by Professor Midori Sawada. This organization provides two courses that one can take to become licensed in horticultural therapy and then work in healthcare facilities providing their service. I was

¹⁵⁹ Ruth Kjaersti Raanaas, Grete Grindal Patil and Terry Hartig. “Health Benefits of a View of Nature Through the Window: a Quasi-experimental Study of Patients in a Residential Rehabilitation Center,” *Clinical Rehabilitation* 26 (2012): 21.

¹⁶⁰ Ibid. 21.

¹⁶¹ Stephen R. Kellert, *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings for Life* (Hoboken, N.J.: John Wiley & Sons, 2005): 254.

lucky enough to attend an open campus day in which I was able to tour and learn about what they do. Professor Sawada is one of the first people to bring this type of therapy to Japan from the United States. She also provides a program for elderly, once a week, to gather together and learn how to garden and work on various projects to stimulate their senses, bodies and minds. On the second day, I attended the elderly program and met the staff and participants.

This type of therapy is beneficial for dementia patients. While at the elderly program with Professor Sawada, she mentioned that she had a participant who had serious dementia and memory problems. Many people with dementia, when they are stressed or feeling lost, say they want to go home or begin to wander. Professor Sawada had a woman with dementia come weekly to her program. When it is rainy or too cold, the program is held indoors, with various hands on activities at the table. When the lady would participate in the indoor activities, she would become unsettled and agitated, and stand up and say she was going home way before the activity was over. However, when the program was held out in the garden, she was very conscious of her surroundings and what she was doing. She was calm, and understood her environment. This woman is just one example of how horticultural therapy can help dementia patients' deal with their symptoms.

In order to understand the program, Professor Sawada informed me on some basic history of elderly care in Japan. There are five different levels of aging in Japan. The highest level that requires the most care is five, with one being the lowest. After the age of 40 years old, citizens are required to pay for nursing care for the elderly of Japan. Since Japan has the leading number of elderly citizens, it has required the government to become stricter with their funding and healthcare. Before, many of the levels of aging in Japan could be in nursing care facilities and participate in daycare centers. Now, the number of elderly requiring care has increased and therefore the lower levels of need have been cut from the nursing and daycare centers. This leaves many with no place to go and no help.

Professor Sawada's knowledge on horticultural therapy led her to start a program that provides the elderly with a place to go once a week on Wednesdays. Even though the

organization receives funding, it is very minimal, only equating to 70,000 yen a year, roughly six hundred US dollars. Since there is such low funding, the staff does not receive pay, but instead is just given money for transportation. The organization also requires each participant pay 700 yen a session, though lunch is provided. With such a tight budget, the staff must be very strict and creative with their budget to provide lunch and activities.

The organization has a focus on horticultural therapy. The therapy is successful when the five senses are stimulated, there is visual accomplishment, the activities are composed of simple, plain actions, there are ample opportunities for going outside, and when the participants have the opportunity to develop empathy.

Another example of a positive outcome out of Professor Sawada's program was seen through another elderly woman. The program makes visits to nursing homes once a week and provides horticultural therapy services. At this facility, Professor Sawada leads the elderly in gardening fruits, vegetables and plants. That day, the group had harvested potatoes. The woman was extremely excited to pull the potatoes out of the ground. During lunch, one of the care providers accidentally gave this woman solid food instead of her typical blended meal. She did not usually eat solid food, and would not even attempt to feed herself. She would wait for someone to feed her. This time, however, when she saw that the potatoes they harvested earlier were for lunch, she began to feed herself and eat the potatoes with no help. The woman's participation in the harvesting of the potatoes gave her a sense of accomplishment and pride, thus she had the desire to eat, or reap the benefits of her hard work.

This woman was able to reap the benefits of horticultural therapy because of a program that she was involved in, but what about those who are not in similar programs, but still want to reap benefits of horticultural therapy? By simply providing easily accessible gardening environments, residents will have a higher chance of gardening and reaping its benefits.

In the United Kingdom, a study was conducted that consisted of a 'semi-structured' interview at a 'sheltered' housing complex and a questionnaire for residents of five other 'sheltered' housing complexes. This study was conducted to understand the

differences in activities performed in nature at home and after moving to a ‘sheltered housing complex.’¹⁶²

For the semi-structured interviews, the shelter was chosen because it contained, ‘three different types of facilities: those for the frail elderly people (with communal dining facilities); those for more independent residents (with communal day facilities); those for the most independent residents (with no communal facilities).’¹⁶³ The complex’s landscaping was diverse and consisted of: formal flower beds, low maintenance ground shrubbery, and informal wildlife. Out of the forty-seven residents, twenty-nine agreed, (nineteen women and ten men.) 32% of the interviewed were within the 60-74 age group, 56% within 75-84 years and 12% within 85-94 years. All of whom participated have lived in the complex longer than one year.¹⁶⁴

The shelter complexes that were given the questionnaires all had ‘high quality landscaping.’¹⁶⁵ There were one hundred and six respondents out of one hundred and ninety-six residents (eighty-four women and twenty-two men). 34% of the respondents were within the 60-74 age group, 46% within 75-84 years and 20% within 85-94 years. 93% lived at the shelter complexes for at least one year.

The information from both the interviews and the questionnaires were combined and analyzed based on:

1. “If there was a significant difference in the use of the sheltered housing grounds in comparison with the use of the grounds in residents’ own homes.
2. If there was a significant difference in the values attached to the grounds of sheltered housing by women in comparison to men. “¹⁶⁶

In figure 1 (next page), you can see that most resident’s time was spent doing passive activities such as sitting outside. The more active uses, such as, growing vegetables or

¹⁶² Suzanne E Wells, *Horticultural Therapy and the Older Adult Population*. (New York: Routledge, 2013), Kindle Edition. 413.

¹⁶³ Ibid. 413.

¹⁶⁴ Ibid. 413.

¹⁶⁵ Ibid. 427.

¹⁶⁶ Suzanne E Wells, *Horticultural Therapy and the Older Adult Population*. (New York: Routledge, 2013), Kindle Edition. 455.

cuttings, were done much less. 94% of residents responded that before moving into the shelter, they had a garden. The second figure shows the activities that residents conducted in their gardens prior to moving to the sheltered homes. It is visible that the frequency of activities is reduced considerably after moving into the sheltered home.

Figure 9 Use of Grounds in Sheltered Housing

Source: Horticultural Therapy and the Other Adult Population, 458.

Figure 8 Use of Ground Lot at Previous Home

Source: Horticultural Therapy and the Other Adult Population, 472.

landscape because it is a public space and not their individually owned land. I think one way to combat this feeling of lack of control is to provide gardening opportunities at a more individual scale. Participants were asked, “If you have a garden now, or if you use the grounds, do you see the outdoors as...” The most common response was “important

It is difficult to determine the reason for the reduction of activities participated in at the shelter home. This is because it could be due to the physical inability that comes with age. Respondents said that the reason they no longer garden is either due to, “poor health or too old.”¹⁶⁷ Even though the grounds were used for less activities, all, but one, respondent said that the grounds were very important.

15% of respondents did not seem to use the grounds, but still considered them important. Personally, I think it has to do with the social aspects and elderly’s comfort levels within the complex. As we age, it is important for us to have control over our environment.

Depending on the complex’s policies and management, some residents may feel that they do not have enough freedom to make changes to the

¹⁶⁷ Ibid. 479.

for the image of your home.” The others with a high number of responses were, (half of women and one fourth of men) “a topic of conversation,” a place to socialize,” and “something to look forward to.”

“Sheltered housing was originally developed to enable older people to live independently within a supported environment. The design and management of the buildings, and to a lesser extent the grounds, place particular emphasis on making tasks easier or eliminating tasks altogether. Generally, less attention has been given to more intangible aspects relating to the quality of an older person’s home life and the importance of continued activity.”¹⁶⁸ Even though not all residents use the outdoor environment, they still value it. “Patterns of land allocation and site design must be reconsidered to emphasize domestic style and provision of private territory.”¹⁶⁹

This study spotlights the issues that designers face when creating community gardens.

Figure 10 Importance of Various Elements Ranked

Source: Horticultural Therapy and the Older Adult Population, 506.

¹⁶⁸ Suzanne E Wells, *Horticultural Therapy and the Older Adult Population*. (New York: Routledge, 2013), Kindle Edition. 507.

¹⁶⁹ Ibid. 524.

How do you provide a space that promotes a variety of activities and keeps elderly actively engaged in nature?

4.3.2 Design Precedents for Horticultural Therapy

Universal design is a common style of design that allows users with various disabilities and elderly to enjoy the same space together. *The Sensory*

Garden (Fureai-no-niwa) in Osaka, is an example of horticulture that stimulates all five of the senses and universal design principles.

The garden is designed based on *The Secret Garden* by Frances Burnett and the responses of over three hundred elderly and people with disabilities. Also, “the

word ‘Sensory’ in Japanese is ‘Fureai.’ It means ‘coming in contact with with flowers, greenery, wind, light, and warm hearts of other people.’¹⁷⁰ The park is half an acre and is broken into five sections according to the senses. Within each section, the garden is designed to have the user’s focus on that one particular sense. For example, the touch garden has a lawn area for people to sit or lay on, and a pond with aquatic plants for people to touch. It is raised for wheelchair users access. The sound garden contains a *Suikinkutsu* within a fountain. A *suikinkutsu*, “ is a traditional Japanese echoing system. It is like ‘a water harp’ in which water drops make delicate echoes in a jar buried underground. *Suikinkutsu* was often used in the Japanese garden for the tearoom many

Figure 11 The Sensory Garden, Oaska Japan

Source: “Linking People with Nature by Universal Design”, 54.

¹⁷⁰Fusayo A. Miyake, “Linking People with Nature by Universal Design.” In *Interaction by Design: Bringing People and Plants Together for Health and Well-being, An International Symposium*, ed. Candice A. Shoemaker (Iowa: Iowa State Press, 2002), 54.

years ago.”¹⁷¹ This allows visitors to listen to the music of water. The taste garden provides edible flowers, the color garden displays harmonious colorful plants, and the fragrance garden contains herbs and fragrant flowers in raised beds so everyone can stop and smell the flowers.

This garden provides a community space in which the senses can be enjoyed by all. It displays simple designs to engage users. Miyake understands the way way people relate to ‘healing landscapes’ in two ways: 1) appreciation through their senses, such as the sensory garden (sight, hearing, smell, taste and touch, or 2) activitely through growing plants, such as, gardening, horticultural therapy, school garden and community gardens.¹⁷² Both provide various healing effects for participants.¹⁷³

¹⁷¹Ibid. 55.

¹⁷² Ibid. 56.

¹⁷³ Ibid. 56.

5 Chapter 5: Design Precedents

5.1 Introduction

It has been proven that most elderly have a strong desire to age in place. This option allows them to grow old within their home that is filled with so many memories. Homes can be sentimental and become increasingly important as one ages. Current homes, however, may be unfit for elderly that have developed physical or mental impairments. Common issues found within all different housing options include: wheel chair accessibility limited by narrow hallway and doors, insufficient supportive technology for those with hearing and eyesight issues, unsafe access to fixtures in bathrooms, difficulties with household appliances such as refrigerators, stoves, washing machines and dryers, windows that are difficult to open and close, slippery and dangerous flooring material, such as, thick ‘high pile carpet’ is difficult to use a wheelchair on, inaccessible cabinets that are too high or too low, exterior sliding glass doors that are too heavy to access gardens or decks, ramps that are too steep and slippery, not enough sound insulation to prevent noise transferring to other apartments, door knobs, and fixtures that are difficult to grasp, slippery floor materials in bathrooms and kitchen sinks that are either too high or too low for easy access.¹⁷⁴

Making these necessary changes to existing homes can become extremely costly and stressful for those who live in the home. Most of the elderly that enter nursing care facilities or elderly housing move suddenly.

“Analysis of persons aged 65+ using the Health and Retirement Survey data reports that only 20% of moves were anticipated 2 years earlier. A major impetus is a health event. Wolf and Wilmoth’s analysis of health shocks and relocation showed that having a stroke or a hip fracture were the two strongest independent predictors of housing relocation in later life.”¹⁷⁵

¹⁷⁴ Kenneth C. Meyer, "The Senior Housing Shuffle Connecting Public Policy to Universal Design, Sustainability, Health Management, and Aging in Place," *Journal of Business Case Studies* 10 (2014): 389.

¹⁷⁵ Mark R. Luborsky, Catherine L. Lysack, and Jennifer Van Nuil, "Refashioning One's Place in Time: Stories of Household Downsizing in Later Life," *Journal of Aging Studies* 25, no. 3 (2011): 244.

This data demonstrates how many elderly individuals do not plan for changes or events that may occur because of aging. Typically, it is not until something drastic happens that changes are made and by that time it has become significantly more difficult of a task because of the possible health crisis event. As elderly individuals develop physical or mental impairments yet continue to use the same dangerous home environments, they put themselves at a higher risk of injury.

5.1.1 Accessory Dwelling Unit

Therefore, it is imperative to plan for all stages of life. Everyone grows older and everyone will develop some sort of impairment as they age. The proposed new housing design is a transportable Accessory Dwelling Unit, (ADU) that can be attached or built separately from the permanent main structure. This ADU structure, would be designed to meet the needs of aging family or occupants. Hawai'i currently is in a severe housing crisis—the demand outweighs the available housing. In order to try to alleviate some of the strain, the Accessory Dwelling Bill, Bill 20, was passed in 2015. An ADU is a living space with a full kitchen, bathroom and sleeping facility, that can be built on existing land, alongside or attached to, the primary dwelling. A single-family home lot must be in a residential or country district and the lot size must be at least 3,500 square feet in order to be eligible. The land cannot be blocked by another home and must have vehicle access and a parking stall. The maximum floor area for a lot size of 3,500 to 4,999 square feet is 400 square feet. For a lot that is 5,000 square feet or larger it can be up to 800 square feet. Because the cost of living is very expensive in Hawai'i, many generations are living together under one roof. The proposed ADU could provide elderly with privacy or income from renting either the unit or the main house. “For older adults who need to downsize because of financial or physical functioning reasons (e.g., difficulty climbing stairs), ADUs serve as an alternative form of housing, whereas for older adults who can remain in their home but require some financial or personal care support, adding their own ADU creates a rental unit or a living space for a caregiver.”¹⁷⁶ On Oahu, there are an

¹⁷⁶Amanda J. Lehning, "City Governments and Aging in Place: Community Design, Transportation and Housing Innovation Adoption," *The Gerontologist* 52, no.3 (2012): 347.

estimated 15,098 properties that could potentially accommodate an ADU unit.¹⁷⁷ The bill was passed in hopes of minimizing urban sprawl, utilizing existing infrastructures and available land, providing additional income for landowners, and promoting aging in place.¹⁷⁸ The units ability to be transported to a residential low-to-mid-rise and be ‘plugged-in’ allows for residents to remain in their home, thus reducing anxiety or depression caused by moving in old age, minimizing healthcare costs of a nurse and creating more opportunities to socialize. By designing a prefabricated ADU, there is more quality control of the products of construction. Construction time is reduced. Homeowner’s levels of stress during construction are reduced. ADUs also allow for flexibility of size and elements through modular design. Modular building designs are not new concepts. The basics can be found in construction systems from around the world and the traditional architecture of Japan.

5.1.2 Influence of Traditional Japanese Architecture

Japan has played a significant role in innovative housing prototypes such as modular buildings. Their rapidly aging population, pursuit of technological advances, and the cultural importance of temporality have played a large role in their abundant housing types. “In Japan for example, housing has been the norm for nearly a generation. There is a sense that prefabricated homes are modern and well suited to contemporary lifestyles.”¹⁷⁹ These modern construction systems were influenced by the Japanese traditional construction style of the post and beam construction, tatami mats, and shoji screens. Traditional Japanese architecture has had a global influence on transformative and adaptable furniture and interior environments. Understanding the origins of these architectural concepts helps one understand the reasoning behind the benefits of the utilization of these elements. The physical elements of the Japanese traditional home’s construction are ingrained in their spirituality.

¹⁷⁷ “Where Can We Fit ADU’s in Honolulu?,” OURchitecture (All Kinds Drafting Service,) accessed November 29, 2016, <http://allkindsdrafting.blogspot.com/2010/06/where-can-we-fit-adus-in-honolulu.html>.

¹⁷⁸ “City & County of Honolulu Basic ADU Requirements,” HawaiiADU, accessed November 15, 2016, <http://hawaiiadu.org/whatisanadu/#requirements>.

¹⁷⁹ Stanley Russell, “Metabolism Revisited- Prefabrication and Modularity in 21st Century Urbanism,” *Without a Hitch: New Directions in Prefabricated Architecture*. 249.

The Japanese are very familiar with the ephemeral. As a culture that built primarily with wood up until modern times, they understood that fire, typhoons, or earthquakes can destroy a wooden structure very quickly. They believe that concrete elements were doomed to decay or deteriorate and that only style was everlasting. “A westerner would probably insist that style is inseparable from the physical, concrete form, but, to go one step further, what the Japanese wanted to preserve was not even the style as such, in all its details but something else, some intangible essence within style.”¹⁸⁰ This exact thought is the reason for the dismantling and reconstruction of the Ise Shrine, on an adjacent site, every twenty years since 690 AD. The preservation of this complex has allowed people today to see not only the architecture of the past, but also the culture and religious practices of that time. It has played a significant role in the development of traditional residential Japanese architecture.

The origins of traditional Japanese architecture stem from the tools and trades brought to Japan from immigrants. Prior to the introduction of iron tools and the ability to cultivate rice, the people of Ise lived in fear of the forces of nature, its ability to take things in an instant. However, when wet-rice cultivation was introduced, there was a surplus of food and prosperity. The iron tools were used to construct elevated-floor granary structures to store food. These new structures were at the center of these communities and eventually adopted a somewhat spiritual meaning. The surplus of food, reduced the people’s constant fear of the forces of nature and instead began to celebrate nature’s gifts. The granary structure began to take on a religious meaning and became the model for the basic architectural design of the Ise Shrine. The basic concepts found in the Ise Shrine design influenced the iconic Japanese residential architecture that is known today.

The Ise Shrine had no diagonal structural members because of the need for the building to sway during earthquakes. This led to a Mondrian pattern—the use of only horizontal and vertical elements. These have an ancient association with the *shiki*, the sacred pebbled area, and *himorogi*, the *sakaki* tree. The preference for the gabled roof,

¹⁸⁰ Shinbunsha Asahi, *Prototype of Japanese Architecture* (Cambridge, Mass, M.I.T. Press, 1965), 202.

seen as more urban, also led to the Japanese preference for straight lines. Since straight lines are preferred, any sagging or bending of wooden elements would be both detrimental to the aesthetics as well as the structural strength. The Ise Shrine was originally rebuilt for the prevention of the warping of wood. Japanese have rebuilt the Ise Shrine every 20 years because the style and essence of the building takes precedence over the actual physical preservation of the traditional building.

Another feature that influenced Japanese residential architecture is the designated area of sacred structures to hear oracles from a shaman. It led to the Japanese interpretation of the relationship and division of interior and exterior space. The shaded veranda space became an intermediary space between the two.

The *Shinden-zukuri* style of free and open space was originally from Chinese building design.

“The entire Japanese home (widths and depths of spaces) is based on a standard unit of measurement, *ken*, which originates from the distance between column centres in Chinese temple construction. The dimensional system serves as a frame of reference for all components- timber structure, tatami mats (2 mats= 3.3 square meters/35.5 square feet= 1 *tsubo*), doors, and furniture. Change is further enabled with the structural design as a framed system of thin columns (with widths of 12 to 15 centimeters/ 5 to 6 feet to fit within the outer walls), beams and trusses (*wagoya*) that can easily be removed or added. Moreover, multi-functional rooms referred to as *wa-shitsu* (a largely empty stage deriving its identity from its temporary occupants) are connected to each other and the exterior by light, double sliding partitions and windows, (*fusuma and shoji*) which are easy to shift, remove and store. Ample storage space, *oshiire*, is another important aspect as all furniture is storable.”¹⁸¹

It was transformed to meet Japanese lifestyle. Originally these homes with movable furniture were for the aristocracy of the time. Tatami mats were brought out

¹⁸¹ Robert Schmidt and Toru Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture," *Architectural Design* 84, no. 2 (2014): 77.

only to sit on and stored away after. Eventually, however, tatami mats were used on the entire floor to provide flexibility to the home.¹⁸² These elements have become the most iconic features of traditional Japanese architecture and are the basis of the flexible and adaptable furniture and interior spaces that are proposed in this document. The flexibility of these elements provides the resident with control over their environment and allows for changes to be easily made.

Grid planning has been used in building design since medieval times. An example is the Izumo Shrine. The tatami mat size varied according to the distance between the center and adjacent post. Eventually the creation of towns and market economy led to the standardization of the tatami mat size, as well as other construction elements. The tatami mat's dimensions made it difficult to fit different sized rooms together neatly. This led to the preference for staggered rooms and a closer connection to nature. The spaces between rooms became gardens. The gardens did not have to be large, but each had to be able to be viewed as if it were framed. This standardization of construction elements is an example of successful prefabrication hundreds of years ago.

Today, Japanese have many traditions that pay homage to the ceremonial rebuilding of the Ise Shrine every twenty years. The basic task of replacing the paper of shoji screens, the recovering of tatami mats, and the redecoration of the home at New Year's both represent this idea of preservation through renewal. The ephemeral qualities of Japanese life and culture are carried into modern times with the constant reconstruction of buildings in Tokyo. "(In Japan) buildings are designed in the expectation not that they will stand the test of time but that they will be torn down sooner rather than later and replaced by something more appropriate to the economic and technological demands of the future."¹⁸³ Japan has experienced many earthquakes, fires, and tsunamis, therefore they understand that nothing is eternal and this can be seen in many elements of their culture.

¹⁸²Shinbunsha Asahi, *Prototype of Japanese Architecture* (Cambridge, Mass, M.I.T. Press, 1965), 206.

¹⁸³ Zhongjie Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past," *Journal of Architectural Education* 65, no. 1 (2011): 11.

These distinctly Japanese architectural ideas were deeply influenced by the design of the Ise Shrine and shrine architecture as a whole. Without shrine architecture, the traditional Japanese residential architecture might not include the building with an elevated-floor, verandas, horizontal design, and flexible floor plans that we know today. Thus, the traditional Japanese home provides an opportune framework to accommodate changing conditions - mixing physical, spatial and operational tactics.¹⁸⁴ This flexibility can complement the concept of aging in place. Through modifications and adaptive elements, the ADU can accommodate the environmental needs of physical and mental ailments for elderly residents.

5.1.3 Modern Modular Design

The modularity of a building can be comprised of small elements, such as a single wall, or large scale sections of the building. It is composed of standardized elements that can be attached, removed, and moved to create new forms. This modular technology enables construction times and costs to be reduced by up to half that of traditional building techniques while remaining significantly more environmentally friendly.”¹⁸⁵ There are three types of modular design: closed, open, and mixed systems. Prior to bringing the prefabricated elements to the site, the closed system offers various layout options to choose from, but once decided, the pieces interlock and limit the ‘interchangability’ of pieces.¹⁸⁶ The benefit of this system is that it is more economical, however, it lessens the possibility of the building growing larger once it is installed at the site. The open system is more flexible and usually consists of a structural framing and modules that can be removed or added at any time. The mixed system utilizes both permanent and impermanent elements. While the closed system is a more economical choice, the main focus of research of modular housing, for this document, is open and mixed systems that provide flexibility to floor plans.

¹⁸⁴ Robert Schmidt and Toru Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture," *Architectural Design* 84, no. 2 (2014): 77.

¹⁸⁵ Stanley Russell, "Metabolism Revisited- Prefabrication and Modularity in 21st Century Urbanism," *Without a Hitch: New Directions in Prefabricated Architecture*. 250.

¹⁸⁶ *Ibid.* 251.

Therefore, after understanding the issues that elderly face and the values that are important for housing this growing population, compiled below are precedent studies that are relevant to the proposal of an innovative elderly housing type. The sections below consist of: small homes, transportable homes, flexible interior floorplans, adaptable architecture, and large metabolic buildings. Looking into small homes and transportable homes present information on successfully built projects that provide inspiration and logical support to the proposed accessory dwelling unit design. Precedents with flexible interior floorplans and adaptable architecture provide a basis to the design of the interior environment. By providing flexibility to the space, the elderly resident will have more control over their environment and meet the changing needs as they age and opportunities to make their space customized. The large metabolic building precedents look at how small individual units can be attached to an existing building core and how the units can be removed.

5.2 Flexible Interior Floor Plans and Adaptable Architectural Features

Small spaces require innovative storage and flexible interior floor plans. “Incorporating accessibility features is associated with a lower risk of health problems, slower decline in IADL independence, and reduced health care expenses.”¹⁸⁷ Small spaces can become cluttered with items and dangerous, if there is not enough available storage, therefore within the proposed accessory dwelling unit, it is important to provide sufficient storage in all areas of the home. This will allow for easy accessibility of spaces and hopefully reduce the amount of opportunities for accidents. However, since space is limited, the storage must not have only one purpose, but also provide another function, to maximize the use of space. The storage and interior elements should be adjustable to allow for changes if necessary. Below are four precedent projects that display innovative ways of organizing interior environments, while providing flexibility to the layout. The last three out of the four precedents have moving partitions, which also help to promote everyday simple physical movement, as mentioned in Chapter 4.1 of this document.

¹⁸⁷ Amanda J. Lehning, "City Governments and Aging in Place: Community Design, Transportation and Housing Innovation Adoption," *The Gerontologist* 52, no.3 (2012): 247.

5.2.1 Raku-Inkyo Research Project

An example of a modern day architecture that is adaptable and uses elements found in traditional Japanese residential architecture is the Raku-Inkyo Research Project. As previously mentioned, aging in place is beneficial for elderly. The majority of older adults want to remain in their homes as they age. There is an example that uses simple modifications to everyday residential elements to give them an additional use. “Adaptability in this conceptual space emphasizes an architecture of transience, a disjunction between use and space, and ultimately buildings as unfinished products in a perpetual making, which as demographics change can respond to society’s changing needs.”¹⁸⁸ This ‘perpetual making’ is similar to nature. Nature grows and changes to meet different seasons. Thus, adaptable furniture adapts to the changing physical needs as one ages. Japan has the highest percentage of people 65 years and older at 23%, which is projected to increase to 40% by 2050. Japanese have the highest life expectancy of women 86 years and men 80 years.¹⁸⁹ People who live longer are typically seeing the development of more ailments because the older they get, the more the body breaks down. This perpetual decrease in physical and mental abilities put elderly individuals at a higher risk of injury when living alone. The change in household demographics leaves

Figure 12 On the Left the Bathtub Exposed, On the Right, Covered for Seating

Source: Robert Schmidt and Toru Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture," *Architectural Design* 84, no. 2 (2014): 76.

¹⁸⁸ Robert Schmidt and Toru Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture," *Architectural Design* 84, no. 2 (2014): 76.

¹⁸⁹ *Ibid.* 76.

many elderly adults living alone. This means that many of the homes in which they are living in are unsuitable to the physical and mental changes that accompany aging. Therefore, because of the large population of elderly in Japan and the lack of elderly housing available, the government has funded many housing experiments. In 1990, the skeleton-infill (SI) building system was established. This basic construction style is a modular system made up of two main elements. “This simplified approach produces buildings in two steps: first the skeleton (s) (including enclosure and most utility systems), which is the permanent framework and walls of the building; and second the infill (I), or fit-out, which represents the more temporary parts that can be moved or adapted, increasing the degree of flexibility of the floor plan.”¹⁹⁰ The SI concept allowed existing apartments to be easily modified for the needs of the aging. Instead of institutional living, the elderly were able to live at home and make changes to their dwellings (age in place.) “The capability to remove the infill system was also important here as the need was viewed as temporary. The system developed a menu of nine infill components used in three residential applications to convert a specific area (with both dry and wet spaces) of an existing apartment to accommodate an elderly individual.”¹⁹¹ The

Figure 13 On the Right the Toilet Exposed, On the Left the Toilet Covered

Source: Robert Schmidt and Toru Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture," *Architectural Design* 84, no. 2 (2014): 76.

¹⁹⁰ Robert Schmidt and Toru Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture," *Architectural Design* 84, no. 2 (2014): 78.

¹⁹¹ *Ibid.* 78.

infill components focus on the bathroom elements and room partitions. In the restroom, the toilet is designed for typical toilet function. However, there is a wooden encasement to hide the toilet when not in use. When the toilet is enclosed, the wooden encasement can be used as a table. The bathtub also has a dual purpose. Similar to the toilet, the bathtub comes with a wooden cover to allow the bathtub to function as a platform for two people to sit and drink tea on. While the sink does not have a cover, the design is appropriate for use as a washbowl (depth and shape) or as a kitchen sink (flat base.) The 'wet room' (or bathroom) is adjacent to a balcony. The dining table is located between the 'wet room' and 'dry room.' The table is designed to fold down to allow the sliding partitions to close. Another infill component is the demountable sliding partitions. These partitions provide the resident with the opportunity to remove the partitions, thus allowing flexibility in the floor plan, as well as giving the user control over their environment. The handrail is blended into the design of the door and one must lift up to open the door. The door locks into place when pushing down on the handrail in order to prevent falling accidents. The bed is another feature that is adjustable. It is able to slide left to right on a wall track. The wall handrail also acts as a shelf for resident's items.¹⁹² The simple attachments and modifications give typical household appliances and furniture dual purposes. This allows for the maximization of space and gives the resident control over their environment, as well as the ability to make any necessary changes to meet their necessities.

For example, in the proposed accessory dwelling unit design, if the elderly resident reaches a point where it is unsafe for them to take a bath or use the restroom without assistance, these covers can be employed to ensure their safety and provide another use for the objects.

5.2.2 All I Own House

As mentioned in the Chapter 3.4.1 of this document, as people age, they become more reliant on their environment. In particular, various items that they have collected over time become sentimental pieces of their past. As people move away or pass away

¹⁹²Robert Schmidt and Toru Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture," *Architectural Design* 84, no. 2 (2014): 78.

they are sometimes the only things to remember them by. After older adults stop working, once their children move away and they start developing ailments, much of their time is spent reflecting on life. That is why photos and memorabilia play such an important role in their lives. Therefore, when designing a home for elderly, it is important to think of how to display and store their items.

The Project “All I Own House” by PKMN Architectures is located in Madrid. An existing single-family home was renovated to store all of Yolanda Pila’s, the homeowner, belongings. “The house is designed on the premise that people form unique and special relationships with their personal belongings. Through accumulation of various possessions, each imbued with its own story, PKMN asserts that ‘we become... emotional interior designers.’ Operating from the belief that personal identity can be read through personal affects, the designers strove to craft a space in which the client’s possessions took precedence.”¹⁹³ The home contains three large suspended wooden storage units. Within these sliding storage elements, there is 398 cubic feet of storage. There is a bookshelf, storage for shoes, household items, cleaning supplies, clothes, a kitchen counter, and a bed. They weigh

Figure 14 The Bedroom Configuration

Source: PKMN Architectures Creates Sliding Transformer House in Madrid,” Arch Daily, accessed April 20, 2016, <http://www.archdaily.com/566605/pkmn-architectures-builds-transformer-house-studio-in-madrid..>

Figure 15 The Storage Partitions Pushed to Provide Space in Kitchen

Source: PKMN Architectures Creates Sliding Transformer House in Madrid,” Arch Daily, accessed April 20, 2016, <http://www.archdaily.com/566605/pkmn-architectures-builds-transformer-house-studio-in-madrid..>

¹⁹³“PKMN Architectures Creates Sliding Transformer House in Madrid,” Arch Daily, accessed April 20, 2016, <http://www.archdaily.com/566605/pkmn-architectures-builds-transformer-house-studio-in-madrid..>

1102 pounds and when full, 1764 pounds, but are very easy to move because of industrial rails.¹⁹⁴ This project is another example of adaptable and transformable furniture and interior spaces. The movable storage partitions allow for different configurations of the room, a larger open space, and physical activity to use different elements of the home. While these storage units are quite large and may not be directly applicable to the ADU design for elderly, the concept of sliding storage elements can be applied at a smaller scale.

5.2.3 Casa MJE

PKMN Architectures also designed this next project, the Casa MJE. The project consists of movable and transformable storage elements and is located in Salinas, Asturias, Spain.¹⁹⁵ The area of the space is 753 square feet. The floor plan can be reconfigured three different ways: with no bedrooms, one bedroom, or two bedrooms. This is through rotatable storage elements, similar to those in the “All I Own House.” Through these rotating storage partitions, the space in the small apartment is maximized

Figure 16 The Storage Partition Rotating to Provide More Space to Interior

Source: "Mje House (Little Big Houses #2)/ Pkmn Architectures," ArchDaily,
<http://www.archdaily.com/774668/mje-house-little-big-houses-number-2-pkmn-architectures>.

¹⁹⁴ Ibid.

¹⁹⁵ "Mje House (Little Big Houses #2)/ Pkmn Architectures," ArchDaily,
<http://www.archdaily.com/774668/mje-house-little-big-houses-number-2-pkmn-architectures>.

and allows for maximum customization. The design of the ADU for elderly individuals will need to be relatively small in order to be transported and attachable to a permanent core, therefore these homes that have extremely flexible floor plans provide older adults with more options for the layout of their homes. These moveable partitions are similar to the traditional Japanese home in the sense that the walls are movable. The differences, however, is that the walls contain storage and they not only slide, but also rotate. The sliding and movable partitions allow for an extremely flexible floor plan.

5.2.4 Drawer House

The architect, Oki Sato, established the “nendo” architectural firm in 2002, and designed a residential project called the Drawer House. It is located in Tokyo and was built in 2003. The design received several awards. Tokyo is one of the most densely populated cities in the world, therefore the land square footage is extremely limited. Homes are typically much smaller than ones found in the United States. With such limited space, architects design innovative ways to live and store items. This particular

Figure 17 The Bookshelf Drawer Pulled Out & the Kitchen Space Open

Source: “Drawer House,” Nendo, accessed November 10, 2016,
<http://www.nendo.jp/en/works/drawer-house/>.

project consists of an open floor plan with an entire wall of drawers. By pulling out a drawer, the resident can access the elements that are needed for daily life.¹⁹⁶ Within the wall there consists a bed, television, bathroom, kitchen, bookshelf, additional beds, and storage. This layout leaves many opportunities for the resident to customize the space and allows for more open space when objects are not in use. The use of pullout drawers could be integrated into the design of accessory dwelling units for storage of their numerous items, as well as reduce the amount of square feet taken up by permanent elements.

5.3 Small and Transportable Home Precedents

Today, there is a national movement promoting the use of tiny homes. It has become so popular that there is an even television show. This new interest in smaller homes exemplifies a shift in our social thinking and people's desires. The original American Dream was to own a large home with a large yard and a white picket fence. With the costs of construction and materials on the rise, financial instability, global warming, and the sustainability movement, people are seeing the benefits of decreasing their home size. Smaller homes are less expensive to buy and maintain, and they allow for the flexibility of moving the home to another location. As described in Chapter 3.4.1, as people age, their environmental scope begins to decrease. An elderly individual living in a large home will typically localize the most important everyday items in one room for easy access. Therefore, a smaller unit would work well for elderly adults who feel their single-family home is too large and wish for a smaller unit to live in. Below are precedent studies of innovative transportable home designs. The designs understand that transportability limits the square footage and shape of the building, but the designs use features such as extruding elements to expand the unit for additional space once transported.

5.3.1 Lot-ek MDU Shipping Container

Home financial feasibility for projects of prefabrication is an issue that needs to be addressed, especially when trying to provide affordable housing for elderly individuals. In order for prefabrication to be affordable, there must be a large of demand

¹⁹⁶ "Drawer House," Nendo, accessed November 10, 2016, <http://www.nendo.jp/en/works/drawer-house/>.

and widespread support of prefabrication. One way many architects are providing affordable housing and commercial spaces is through the use of existing shipping containers. These structures are great for modular and transportable units because they are very structurally sound. Shipping containers can be manipulated to meet different design requirements. An example of this is the MDU (Mobile Dwelling Unit), designed by Lot-ek architects based in New York City and Naples, Italy. This project took a single shipping container and cut sections of the wall ‘sub-volumes’ and extruded them out. The square footage is 500 square feet and was completed in 2003 for the University Art Museum in Santa Barbara, California. This allows the space of the shipping container to increase in size when in use. When not in use, the ‘sub-volumes’ can be pushed in and interlocked, allowing the structure to be shipped internationally. The MDU was designed for people who frequently travel internationally.

The interior spaces are constructed of “plywood and plastic coated plywood, including all fixtures and furnishings... The MDU travels with its dweller to the next long term destination, fitted with all live/work equipment and filled with the dweller’s belongings. However, it is easily configured for permanent residency.”¹⁹⁷ While there

Figure 18 The Lot-Ek MDU Shipping Container Home with Extrusions Pulled Out

Source: “MDU (Mobile Dwelling Unit),” Lot-Ek, accessed November 10, 2016, <http://www.lot-ek.com/MDU-Mobile-Dwelling-Unit>.

¹⁹⁷ “MDU (Mobile Dwelling Unit),” Lot-Ek, accessed November 10, 2016, <http://www.lot-ek.com/MDU-Mobile-Dwelling-Unit>.

are no floor plans or sections online of the MDU, the concept of these retractable ‘sub-volumes’ provides an opportunity for units that are larger than the standard shipping information. It also uses an existing shipping container, which is more sustainable and possibly cost effective. Issues that arise with this design include finding and utilizing a preexisting shipping container, and cutting out large sections of the wall, which can cause structural issues. The long-spanning walls are loadbearing and when cut into require additional structural support to make up for cut sections. This shipping container home has been exhibited at the Whitney Museum of American Art, New York, Walker Art Center, Minneapolis, the University Art Museum, and UCSB.¹⁹⁸ Even though this project has not actually been lived in, it is a model for an innovative stance on housing using existing shipping containers. Transportable homes are narrow because of the width of roads. However, the ability to extrude sub-volumes out allows for the interior space to widen when on site, and still can be transported. While, the proposed accessory dwelling unit will not be made of existing shipping containers, this concept of extruding sub-volumes can be applied.

5.3.2 Portable House

The Portable House by Abaton Arquitectura is 9x3 meters (29.5 x 9.8 feet), which is within the size restriction for oversized goods by vehicle or truck in Spain. The home can house up to two people. The interior is made of wood, which is a renewable resource. The exterior façade is composed of a grey cement wood board and the structure is constructed of solid timber.¹⁹⁹ The time for manufacturing is four to six weeks and it is assembled within one day. This project is a precedent study because the simple yet elegant design will appeal to all ages. It is also easily transportable and uses simple materials for both facades and structure. While I appreciate the use of solid timber wood for the structure, wood can be easily damaged, and it would not allow for easy mounting and demounting of units to the permanent building structure. Therefore, the structure is not what is applicable to the and proposed design, but the dimensions, and interior and exterior materiality can be applied to the proposed accessory dwelling unit. There have

¹⁹⁸ Ibid.

¹⁹⁹ “Portable House APH80/ Abaton Arquitectura,” Arch Daily, Last modified August 27, 2013, accessed April 20, 2016, <http://www.archdaily.com/420623/portable-house-aph80-abaton-arquitectura>

been many studies completed on the health benefits of exposure to nature, as mentioned in Chapter 4.3 of this document. Including plants inside homes can improve air quality and increase their exposure to nature, but they take up space, and can attract bugs.

However, one can reap similar benefits from just exposure to wood materials in the interior environment. The exposure to natural wood can help reduce blood pressure. A study completed in Japan analyzed the physical responses of fourteen people to the view of a wood panel and a steel panel.²⁰⁰ Those who liked the look of the wood panels experienced a decrease in blood pressure. Those who did not like look of the panels did not experience any stress from them. The dislike group for the steel panels, experienced an increase in blood pressure. The group that liked the steel panels experienced a decrease in blood pressure, however the number was too low to be “statistically tested.”²⁰¹ While wood may not be aesthetically pleasing to everyone, it does not cause stress, like some man-made materials. The exposure to the wood panels was concluded to help reduce the feelings of depression, while the white steel panels increased feelings of

Figure 19 Portable House with Exterior Open

Source: “Portable House APH80/ Abaton Arquitectura,” Arch Daily, Last modified August 27, 2013, accessed April 20, 2016, <http://www.archdaily.com/420623/portable-house-aph80-abaton-arquitectura>

²⁰⁰ Satoshi Sakuragawa et al., "Influence of Wood Wall Panels on Physiological and Psychological Responses," *Journal of Wood Science* 51, no. 2 (2005): 136.

²⁰¹ Satoshi Sakuragawa et al., "Influence of Wood Wall Panels on Physiological and Psychological Responses," *Journal of Wood Science* 51, no. 2 (2005):139.

depression, and decreased vigor.²⁰² “Another study was conducted in Japan on the changes in the behavior of residents of an assisted living home caused by the addition of wood products.²⁰³ The study found that the use of wood products increased participants social interaction “between frail elderly, improved emotional relations based on cognitive function, and expanded self-expression in a positive way.”²⁰⁴ Environments with wood products and furnishings can help promote socialization and friendliness. “This finding is potentially significant for the well-being of the elderly because much previous research has connected social interaction with emotionally rich relationships and has found that chances of self-expression reduce the risk of dementia and health decline.”²⁰⁵

These studies are just a few that portray the importance of exposure to natural material in the interior environments. The Portable House by Abaton Arquitectura, used the wood for their interiors for the hypoallergenic properties and the renewable quality, however the benefits far exceed their reasoning. Therefore, the use of natural finishes within the proposed accessory dwelling unit, will help to increase resident’s exposure to nature through natural materials, as well as, hopefully promote socialization.

5.3.3 Remote House

The Remote House is 80 meters squared and is composed of four identical modules that are 3.5 meters by 6 meters.²⁰⁶ These measurements are according to the maximum width and height of road transportation in Chile. The whole structure was built in 45 days, moved in four hours, and installed within six hours. It contains three bedrooms, two bathrooms, a pantry, living room, dining room, and kitchen. The structure is made up of iron with wood interior finishes. The foundation consists of preinstalled pillars. The plumbing and electrical were installed after the modules were mounted. This precedent was included because of its ability to expand or contract to a smaller home to meet the changing needs of a client due to its modular system. The simple units can be

²⁰² Ibid. 139.

²⁰³ Anne T. et al., "Behavior Changes in Older Persons Caused by Using Wood Products in Assisted Living," *Public Health Research* 2(4) (2012): 106.

²⁰⁴ Ibid. 109.

²⁰⁵ Ibid.109.

²⁰⁶ “Remote House/ Felipe Assadi,” Arch Daily, accessed August 20, 2016, <http://www.archdaily.com/770102/remote-house-felipe-assadi>.

combined to make larger spaces and modules can be removed when less space is needed. The location, or mobility, of the home is not the only important element in the well-being of our elderly, it is also the interior space and design. When we move into a house, it is only through the formation of habits and creating an emotional connection to the space that a home is created. Without the formation of these habits in one's apartment or home, they have no meaning. With such a large distinction between a house and home, involuntary separation from one's home can be a very traumatic experience, especially for fragile elderly adults. As we age, our five senses are decreased. Our eyesight and hearing are decreased, the sensation of touch is reduced, we might even lose our sense of smell and taste. This decrease in senses causes older adults to become increasingly dependent on their immediate surroundings, thus requiring them to be very familiar with it. And for many, moving residences can have negative effects on one's quality of life.

Figure 20 One of the Modules of the Remote House

Source: "Remote House/ Felipe Assadi," Arch Daily, accessed August 20, 2016, <http://www.archdaily.com/770102/remote-house-felipe-assadi>.

Figure 21 Modular Remote House

Source: "Remote House/ Felipe Assadi," Arch Daily, accessed August 20, 2016, <http://www.archdaily.com/770102/remote-house-felipe-assadi>.

5.3.4 Portable House by Office of Mobile Design

Figure 22 The Portable House at A Site with Many Others

Source: Martin Nicholas Kunz, *Best Designed Modular Houses*, (Stuttgart : AVedition, 2005), 127.

The Portable House by Office of Mobile Design (Jennifer Siegal) in Venice, California is a modern take on a mobile home.²⁰⁷ The portability of the unit requires the unit to be able to adjust to different climates. The house can be expanded and contracted similar to the design of the Lot-ek MDU Shipping Container Home, however this unit is not made from an existing shipping container. A great feature of this project versus the Lot-ek project is the concentration of the expandable extrusion. Instead of multiple smaller elements that are expanded and contracted, a larger portion is extruded, thus reducing the number of possible leaking issues. The mobile home is prefabricated in a factory. She also proposed for the unit to be combined with others in an Ecoville, where units can be brought together to create a community. The Ecoville project is a design for the Artists-in-Residence in downtown Los Angeles. The community contains both attached and detached buildings, with modular units stacked.²⁰⁸ This precedent is a great example for the transportable accessory dwelling unit, however the design is very modern with the use of a lot of exposed steel. This look maybe necessary for the permanent structure for the unit to be plugged into, but the look of the unit should use more natural materials as seen in the Portable House by Abaton Arquitectura.

²⁰⁷ Martin Nicholas Kunz, *Best Designed Modular Houses*, (Stuttgart : AVedition, 2005), 126.

²⁰⁸ Martin Nicholas Kunz, *Best Designed Modular Houses*, (Stuttgart : AVedition, 2005), 128.

5.4 Metabolic Architecture

In 1960, a book called *Metabolism: The Proposals for New Urbanism*, published independent articles of four architects and one critic and journalist on their thoughts on how to structure Japan's rapidly growing cities.²⁰⁹ The architect Kenzo Tange largely influenced the thoughts of all five individuals: Kisho Kurokawa, Fumihiko Maki, Kiyonori Kikutake, Masato Otaka, and Noboru Kawazoe.²¹⁰ The rapid development of technology and construction influenced Tange to believe that certain elements in the urban setting are changed more frequently than others.

Japanese Metabolist theorists believed that the city is an organic process. This concept was completely opposite of the Modernist theory of the city as a machine.²¹¹ "They proposed that a city would grow, transform, and die like an organism. To accommodate the growth and regeneration of the modern city, they called for establishing a system of urban design distinguishing elements of different scales and durations, namely the "permanent element" such as urban infrastructure, versus the "transient element" such as individual houses.

"Short-lived items are becoming more and more short-lived, and the cycle is shrinking at a corresponding rate. On the other hand, the accumulation of capital has made it possible to build in large scale operations. Reformations of natural topography: dams, harbors, and highways are of a size and scope that involve long cycles of time, and these are the manmade works that tend to divide the overall system of the age. The two tendencies- toward shorter cycles and toward longer cycles- are both necessary to modern life and to humanity itself."²¹²

Tange deemed that infrastructure like highways, bridges, communication channels, and physical structural framing were permanent. Residential and office units were more impermanent and could be plugged into the permanent structure. Responding

²⁰⁹ Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 23.

²¹⁰ Ibid. 23.

²¹¹ Carola Hein and Zhongjie Lin, "Metabolist Utopias and Their Global Influence," *Journal of Urban History* 42, no. 3 (2016): 5.

²¹² Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 25.

to the distinct “metabolic cycles” in the city, the Metabolists’ designs were often characterized by the combination of a megastructure that served as the permanent base, and numerous individual units attached to the megastructure and subject to more frequent replacement.”²¹³

Metabolic architecture is reliant on changeability and adaptability. “The architecture of metabolism was conceived as the architecture of temporariness, as expressed by Buddhism’s concept of impermanence. It was an alternative to the western aesthetic ideals of the universal and eternal. Ise Shrine, Izumo Shrine, and the Katsura detached Palace, because of their respective histories of renewal, were cited as the pretext for this movement.”²¹⁴ One of the five architects, Kikutake, developed a theoretical design called the Marina City in 1963. This design “proposed little round minicapsules that could be plugged into the towers or replaced as needed. It was the first scheme that proposed independent, unconnected capsule tower...”²¹⁵ Kisho Kurokawa was the first to actually build a space frame and mini-capsule building in 1972, called the Nakagin Capsule Tower in Tokyo.

5.4.1 Nakagin Capsule Tower

One of the most well-known projects of the Metabolist movement is the Nakagin Capsule Tower. It was designed by Kisho Kurokawa.²¹⁶ The project is located in the bustling Ginza area in central Tokyo. The design of the building consists of two permanent cores and individual units that attach to the cores (144 units) and the service equipment and sky bridges at the eleventh and thirteenth floors.²¹⁷ Kurokawa designed the units for the professional nomad. Many Tokyo business men live a far distance from their workplace. Their commute can be exhausting and if they stay past midnight, when

²¹³ Carola Hein and Zhongjie Lin, "Metabolist Utopias and Their Global Influence," *Journal of Urban History* 42, no. 3 (2016): 16.

²¹⁴ Stanley Russell, "Metabolism Revisited: Prefabrication and Modularity in 21st Century Urbanism," *Without a Hitch: New Directions in Prefabricated Architecture*. 249.

²¹⁵ Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 30.

²¹⁶ Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past."

²¹⁷ Hein and Lin, "Metabolist Utopias and Their Global Influence." 3.

the trains stop, they may have no way home. Therefore, the units were designed for professionals who needed a place to stay a few nights a week.²¹⁸

The location of Japan on the border of tectonic plates makes the region prone to frequent earthquakes. The building codes have become much stricter since the Nakagin Capsule Tower was built in 1972. However, the building has withstood the frequent earthquakes and the large earthquake of 2011, even though it damaged other areas of Tokyo's infrastructure.²¹⁹ This unpredictability of nature has been one of the key reasons for frequent building renewal in Japan. Japan's deeply rooted ideas of temporality seen in

Figure 23 Nakagin Capsule Tower in 1972, Ginza, Tokyo

Source: Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past." 2.

²¹⁸ Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past." 18.

²¹⁹ Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 15.

the rebuilding of the Ise Shrine every twenty years and the relatively ‘brand new’ image of Tokyo echo the idea of the renewal of the capsules. The *shikinen-zokan*, or ritual reconstruction of the Ise Shrine, is over a thousand years of practice. It is rooted in the Shinto belief of nature’s regeneration. Therefore, this practice of regeneration and renewal can be seen in modern Japanese cities. “(In Japan) buildings are designed in the expectation not that they will stand the test of time but that they will be torn down sooner rather than later and replaced by something more appropriate to the economic and technological demands of the future.”²²⁰ The Nakagin Capsule Tower is an example of a modern take on the Japanese belief of the ephemerality of life.

In nature, every living element has a certain lifespan. Just like in nature, Kurokawa designed the three different types of structure to last different durations or lifespans. The permanent cores were designed to last sixty years and the capsules for twenty-five to thirty-five years.²²¹ “He noted that the life span of the capsule was not a mechanical one, but rather a social one, implying that changing human needs and social relationships would necessitate such periodic replacement.”²²² The units appear to be randomly attached to the core, which allows for more to be attached and removed. He “regarded this incomplete look as the ‘esthetic of time,’ referring to Metabolism’s central notion of the city as process.”²²³ This idea of the city as a process can be applied to accessory dwelling units for the elderly because they can meet the different stages in the ‘process’ of growing old. When an older adult becomes isolated and lonely, their unit would be able to be transported to a permanent structure and the individual would have more possibility of socialization with other unit residents.

The individual unit measures 7.5 x 12.5 x 7 feet and constructed out of welded steel. They are “identical to the shipping container in structure and size- and covered in galvanized rib-reinforced steel panels, anti-ruse paint, and finished with a coat of Kenitex glossy spray. There is a Plexiglas porthole window on each capsule, 41/4 foot in

²²⁰ Ibid. 11.

²²¹ Carola Hein and Zhongjie Lin, "Metabolist Utopias and Their Global Influence," *Journal of Urban History* 42, no. 3 (2016): 606.

²²² Zhongjie Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past," *Journal of Architectural Education* 65 no.1 (2011): 18.

²²³ Ibid. 19.

diameter.”²²⁴ Kurokawa initially considered precast concrete as the main material, but ran into too many issues. The interior spaces have built-in industrial furniture and are complete with a bathroom, kitchen, desk, and bed. The units were constructed by a railroad vehicle manufacturer and transported to the site. Construction for the whole building was finished within one year. The units were sold in 1972 from, \$12,300 to \$14,600, about equal in cost to a luxury car of the time.²²⁵ The units are attached to the core with four high-tensions bolts, two on the top and two on the bottom. This allows the units to be removed and attached. The aesthetic design of the building is similar to traditional ‘wood-block puzzles.’ These interlocking wooden joints are visible in the traditional pagoda and temple design.²²⁶ The interior was equipped with a double bed, desk and chair, HVAC system, TV, tape deck, typewriter storage space, desk calculator, clock radio, two-burner stove, and a bathroom with a Japanese style bathtub. The interior finish was enameled plywood.²²⁷

Today, there is a debate whether the Capsule tower should be demolished, which goes against the core idea of the building. Some of the issues that have caused this demolition debate include: possible use of hazardous asbestos in construction, it’s possible inability to withstand

Figure 24 Axonometric of a Capsule

Source Zhongjie Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past," *Journal of Architectural Education* 65 no.1 (2011):, 9.

²²⁴ Zhongjie Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past," *Journal of Architectural Education* 65 no.1 (2011): 19.

²²⁵ Ibid. 19.

²²⁶ Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 76-77.

²²⁷ Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 71.

earthquakes, lack of maintenance of both the units and core.²²⁸ Kisho Kurokawa Architects & Associates proposed to the property owners to remove the existing units and replace them with new capsules, which would renew the entire building. In their proposed design, the capsules dimension would be: 14 x 9 x 8 feet, which is larger than the previous unit. He also proposed to remove the built-in furniture, except for the restroom. The property owners, however, are still looking for complete redevelopment. Some individual owners of the capsules have done renovations to the units and they function as either offices or the original intention, as apartments. One man, a golf course architect named Ko Sakota, purchased two capsules, one for his office and the other for his apartment. They sold for \$45,000 each and the interiors no longer resemble the Kurokawa's designs.²²⁹ Even though some of units have been renovated by the individual owners, the future of the building is still unknown.

Figure 25 Kurokawa's LC-30X Capsule Design

Source: Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 77.

²²⁸ Carola Hein and Zhongjie Lin, "Metabolist Utopias and Their Global Influence," *Journal of Urban History* 42, no. 3 (2016): 606.

²²⁹ Kishō Kurokawa, *Kisho Kurokawa : Metabolism and Symbiosis = Metabolismus Und Symbiosis*, (Berlin: Jovis, 2005), 67.

After the Nakagin Capsule Tower was built, Kurokawa thought the capsules were very limited spatially. He then designed the LC-30X leisure capsule to address his concern. This design is composed of three connected capsules: one for services, sleeping, and living. The structure is composed of rolled steel 0.13 inch thick. These units could have possibly been attached to a diagonal truss mega-structure near Usami on the Izu peninsula in Japan. It was never built, but there was a proposal for a hillside development utilizing these pods and construction. The most interesting and relevant idea of this hillside concept is the less-intrusive design. Instead of a large indiscreet design, the capsules follow the natural terrain, but still provide more density through overlapping of units.

Even though the Nakagin Capsule Tower was designed to have the capsules replaced every 25 years, this has not been done. One of the possible issues with the flexibility and removability of the units is that besides ‘renewal’ for maintenance purposes, there was no other reason to remove units. This document’s proposal of having the units for the elderly being able to function independently and in clusters provides another possible reason for the plug-in construction. It also resonates with the basic ideologies of metabolism of the organic processes of flexibility, adaptability, and temporality. The temporality of the individual units would work well with the environmental changes needed for the different stages of aging. Within the unit elements could be temporary and adaptable to meet the changing needs as one ages.

Kurokawa experimented with many materials in order to find one that was strong yet light enough to be only attached by four tensile bolts. Since the 1970s, there have been substantial improvements in material strength and quality. For example, a new construction material called long fiber reinforced thermoplastics are composed of long glass fibers integrated into the thermoplastic material.²³⁰ This material allows for curved shapes while still having strength. Another material is reactive powder concrete, which is moldable and does not require the rough, bulky aggregate. With the integration of steel and fiberglass, the material has a 30,000 psi compressive strength as well as tensile

²³⁰ Stanley Russell, “Metabolism Revisited: Prefabrication and Modularity in 21st Century Urbanism,” *Without a Hitch: New Directions in Prefabricated Architecture*. 252.

strength.²³¹ One of the benefits of the use of this material is that it can be much thinner than typical concrete, which reduces weight—it can be as thin as 20mm thick. Steel is most likely the best material for the structure of the proposed accessory dwelling units because of its ability to be attached and detached easily. There have been advances in steel technology that allow for lighter and stronger materials.

Another improvement that can be done to the original design of the capsules is to remove the permanent built-in furniture. The static furniture made the units inflexible. In the Kisho Kurokawa Architects & Associate's proposed design for the new capsules, they removed the furniture except for the bathroom, which will improve the capsules appeal. It would be beneficial for the residents to have furniture included, but modular furniture that could be moved or removed would work best. This would give the capsule owner control over their environment.

The Capsule Tower is an important precedent study for this document because it provides an actual built example of a building that has the ability to attach and detach units to a permanent core. The design is, however, outdated, and the interior spaces are inflexible, which makes it difficult for many users to customize their space. Understanding the issues with the current design informs the design of the proposed accessory dwelling unit. During the 1960s-70s, the Metabolism movement had other built examples of building with both permanent and temporary elements.

Following the completion of the Nakagin Capsule Tower, Kisho Kurokawa designed the Osaka Sony Tower. In his review of the Capsule Tower after it was completed, he realized that mechanical elements are changed more frequently than he initially imagined. Therefore, the Osaka Sony Tower had the mechanical functions on the exterior of the building housed in capsules. In his previous designs, he encountered difficulty with accessing the mechanical systems and therefore made this change.²³²

²³¹ Stanley Russell, "Metabolism Revisited: Prefabrication and Modularity in 21st Century Urbanism," *Without a Hitch: New Directions in Prefabricated Architecture*. 253.

²³² Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 38.

Another similar capsule tower design is the Kibogaoka Youth Castle in Shiga Prefecture built in 1972. It was designed by Tatsuhiko Nakajima and GAUS (Institute of General Arts & Urban Sciences.) The capsules were sleeping and studying modules. The architects used the building as a statement of ‘technological progress’ for the Shiga Prefecture.²³³ There were nine capsules per floor that were connected to a reinforced-concrete cylindrical core. The capsules were attached by cantilevering concrete beams. They were then reinforced with post-tensioning in order to provide more structural stability against earthquakes. The Kibogaoka Youth Castle capsules do not include individual bathrooms, to consolidate all the plumbing in a smaller area.²³⁴ The Oaska Sony Tower and the Kibogaoka Youth Castle are additional built examples of the use of capsules in architecture. Both were employed during the same time as the Nakagin Capsule Tower. Technology has advanced significantly since the 1970s, making it even more feasible to apply an improved design today.

Figure 26 Kibogaoka Youth Castle, Shiga Prefecture

Source: Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 82.

5.4.2 Sekisui Haim Box-Unit

Another precedent study that employs metabolic theory in the design is the Sekisui Haim box-unit. These box units are not all-encompassing housing units, but more similar to building blocks. They are modules that are combined in different ways to

²³³ Ibid. 82.

²³⁴ Ibid. 82.

create a larger building. The Sekiaui Haim box-unit was proposed by Dr. Ohno to the Sekisui Chemical Company in April, 1972. The company agreed to produce the box-unit with the modular open-system. The company began manufacturing the units in 1973 and built 40,000 units a year.²³⁵ The factory is modeled after an automobile assembly line. The factories produce 100 units a day per factory. The units cost around \$3,000 and a completed three-bedroom house combines seven to eight units, for a total cost of \$25,000.²³⁶ Each unit is constructed of light-gauge steel framing and wood infill panels and weighs about 1 ½ to 2 tons. This system of construction provides flexibility to the layout of the home. The company offers 20 variations of the box-unit house.²³⁷

This housing system is a simplified version of the research done by the Uchida Laboratory. Professor Uchida designed a project called the Group Uchida No. 7 housing system. Its basic design is a structural framing that is infilled with prefabricated interlocking box-units.

“Remembering that the basic premise of open-systems architecture is to create a neutral field into which any combination of prefabricated components can be inserted...”²³⁸

This system allows easy replacing of mechanical systems because of prefabricated panels that slide into the skeleton effortlessly. The kitchen

Figure 27 Modular Sekisui Haim Box-Unit

Source: : Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 67.

²³⁵ Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 65.

²³⁶ Ibid. 65.

²³⁷ Ibid. 66.

²³⁸ Michael Franklin Ross, *Beyond Metabolism : The New Japanese Architecture* (New York : Architectural Record Books, 1978), 63.

conduits and pipes are designed as a ‘hot panel,’ “which can be replaced much in the same manner a computer circuit is snapped into your TV set.”²³⁹

The skeleton structural system can accommodate sloping terrain and allows for expansion up, down, or to the sides. The system is based on the traditional Japanese standard dimension of one *shaku*, or approximately one foot.²⁴⁰ The box-unit is 9 feet by 12 feet. These units are then combined (7-8) to create an apartment of usable square feet, or 1,100 total square feet.²⁴¹ The Sekisui Haim box-unit is a simplified version of this system.

While this system is designed for single-family homes, the basic concept can be applied to the transportable accessory dwelling units. The accessory dwelling unit can use a similar framing system with infill panels, to provide the structural stability and interior flexibility to the unit. Another benefit of this project is that the units can be combined to create larger spaces if needed.

5.4.3 Micro Compact Home

A more contemporary project that looks at small individual spaces that can be clustered together is the Micro Compact Home, M-CH. The Technical University in Munich, as well as, the Tokyo Institute of Technology partnered together to design this home. The project was geared towards short-term living space for students and professionals. It began as a research project, but is now available to buy across Europe. The design took inspiration from the Japanese tea house as well as compact living examples from aircrafts, yachts, cars, and micro apartments. The design theory is “less is more.”

Each unit measures 8.7 x 8.7 x 8.7 feet.²⁴² Each unit provides:

- “two compact double beds, 198cm x 107 cm, with covered cushions.
- Storage space for bedding and cleaning equipment.
- Sliding table measuring 105cm x 65 cm, for dining for up to five people.

²³⁹ Ibid. 64.

²⁴⁰ Ibid. 64.

²⁴¹ Ibid. 64.

²⁴² “Tree Village,” Micro Compact Home, accessed November 20, 2016, <http://www.microcompacthome.com/projects/?con=tree>

- Flat screen television in the living/dining space.
- Shower and toilet cubicle.
- Kitchen area fitted with electrical points and featuring a double hob, sink and extending tap, microwave, fridge and freezer units, three compartment waste unit, storage shelves, cutlery drawers with gentle return sprung slides and double level work surfaces.
- Air conditioning, water heating, fire alarm and smoke detectors.
- Thermostat controlled ducted warm air heating or electric under floor are available alternatives.”²⁴³

The units have been used separately as well as in a vertical and cluster sense. An example of an unbuilt cluster community is the *Student Village* at Technical University of Munich in Germany. The village contained seven compact homes and was constructed in 2005. British Professor Richard Hoden and six students would live in the units for one semester, but students requested to stay a whole year. The project was run by Professor Richard Hoden and other colleagues at Technical University in Munich, in conjunction with Horden Cherry Lee Architects of London and Haack Hopfner Architekten of Munich. All the units were located on the ground.

Figure 28 Micro Compact Home

Source: “Tree Village,” Micro Compact Home, accessed November 20, 2016,
<http://www.microcompacthome.com/projects/?con=tree>

²⁴³Ibid.

While this next project was not built, there has been a proposal for a vertical complex called the *Tree Village*. The design is a fifty feet high student housing project, utilizing *micro compact homes*. The footprint of the whole structure is forty square feet. The structure of the building is composed of a central core, with an elevator and stairways, similar to the Nakagin Capsule Tower. This project, however, contains clusters of thin steel columns to provide extra structural support for the units. The thin steel columns are designed to evoke the image of ‘reeds’ as well as not to disturb the existing roots of trees.²⁴⁴ The structure holds thirty micro units and supplies water and electricity “from an internal ring of vertical services ‘reeds’”.²⁴⁵ This possible design displays an example of a contemporary of the Metabolist theory. The Micro Compact Home provides a basis of using the individual unit on a single-family home lot, or attaching it to a vertical core, such as the Tree Village. It is unclear, however, whether this project would allow easy mantling and dismantling of units, or if they are more or less ‘permanently’ attached to the building.

Figure 29 Tree Village with Micro Compact Units

Source: “Tree Village,” Micro Compact Home, accessed November 20, 2016,
<http://www.microcompacthome.com/projects/?con=tree>

²⁴⁴ “Tree Village,” Micro Compact Home, accessed November 20, 2016,
<http://www.microcompacthome.com/projects/?con=tree>

²⁴⁵ Ibid.

6 Summary of Research

As exemplified in this document, Japan and Hawai'i have very similar demographic and land issues. The issue of increasing population, limited land, and high cost of living can be unfavorable for elderly, who no longer have an income from employment. Japan has explored many new innovative ways in which to provide for their elderly. This is why throughout the document there are examples of Japanese programs, homes, and facilities that cater to elderly.

In Hawai'i, as mentioned, there is a severe housing crisis due to the high demand for housing and high property values. This makes living in Hawai'i difficult for lower to middle income individuals, especially elderly seeing as they no longer have a stable income. In 2015, the Accessory Dwelling Bill was passed to alleviate some of the strain.²⁴⁶ The passing of this bill helps residents by having the possibility of additional income from renting the unit out. Growing old can be a wonderful process as it is a period in which one has more free time to explore their interests. However, many times, this period, is burdened by social isolation, depression and stress over financials. Elderly who live within the city of Honolulu have easier access to everyday amenities versus those who live in suburban or rural areas. Within these suburban neighborhoods, there are no stores, making it impossible to walk to anything. Older adults who no longer drive are at a disadvantage and either depend on family, the bus, or the Handi-van for rides. Many do not want to burden their children or grandchildren and will limit their needed trips to accommodate them. Hawai'i has a great bus system. However, a trip on the bus takes much longer than a vehicle, and can be exhausting. A quick trip to the store that should take fifteen minutes, can take a few hours. It is especially difficult for those who have mobility issues. For those who are unable to take the bus, the Handi-van provides the service of picking up someone from their home and taking them to anywhere on the island. It cost two dollars each way.²⁴⁷ While this is an affordable option, the trip can

²⁴⁶ "City & County of Honolulu Basic ADU Requirements," HawaiiADU, accessed November 15, 2016, <http://hawaiiadu.org/whatisanadu/#requirements>.

²⁴⁷ "The Handi-Van," City and County of Honolulu, accessed March 29, 2017, <http://www.honolulu.gov/dts/default/183-site-dts-cat/1881-thehandi-van.html>

become very long, because of the other passengers. For those who wish to have easy, everyday access to amenities, moving the accessory dwelling unit to the community site is a great option. It allows them to stay within their home, surrounded by their memorabilia, and move to another site. This option can reduce the stress often induced by moving homes.

Remaining within a familiar environment or home is important, but the interior elements can influence the well-being of the resident. Habits that promote healthy aging are physical activity, socialization, nutrition, and horticultural therapy. By integrating architectural elements that promote these activities, and provide a safe environment, will positively influence the lives of residents.

One's environment can play a key role in the development of a healthy lifestyle. Especially for elderly, it is important to provide homes that offer a sense of privacy, security and control. As people age, they begin to reflect on life, their accomplishments, their memories, and whom they shared them with. They collect memorabilia, photos and items to remind them of those times. Therefore, when designing a home environment for the aging, one must provide sufficient area to display these precious items. They are the pride and joy for many older adults and act as a conversational piece with guests.

With the development of mental and physical ailments, one might need to make changes to their environment to provide easier access and movement. Therefore, interior spaces must have flexible floorplans, with modular elements that can be moved, removed, or replaced easily. This will reduce the cost of construction, if changes are necessary. These ailments, however, may reach a point in which one is no longer able to easily care for themselves. At this point, it may be necessary to higher assistance. The transportable modular accessory dwelling unit, provides the elderly individual the option to move their unit to a different location. At this new location, the unit could be then be attached to an existing structure that would provide amenities, such as daily assistance, hair dresser, cafeteria or restaurant, small grocery store, and community spaces. Moving the unit not only allows for daily assistance, it also allows the individual to socialize and participate in more activities within the community. Having the ability to take their unit with them reduces the stress and anxiety, one feels when moving. This is especially

important as you age, because as one ages, they become more reliant on their surroundings and home environment. This proposed design would allow for older adults to prepare for the possible need to downsize or receive healthcare.

By analyzing precedent studies with flexible floorplans and adaptable furniture, small and transportable homes, and metabolic architecture, the proposed design will attempt to incorporate the most successful elements of each.

7 Application in Design



7.1 Transportable Unit Design Proposal

7.1.1 Transportation Laws

In Hawai'i, the Department of Transportation has strict transportation laws for oversized and overweight vehicles. The legal limits for an oversized container is nine feet wide, with a maximum height of thirteen feet and six inches. The length is fifty-eight feet, that of a semi-trailer, with a maximum total of sixty-five feet long. These dimensions are allowed on Hawai'i roads without a permit. Containers with larger dimensions require a permit and escort for transportation. The total maximum width with a permit is sixteen feet wide.²⁹³ The height and length have no set limit, however based on the travel route, there may be limitations. Vehicles with a width wider than twelve feet must have a lead escort, and those over fourteen feet must have two escorts.²⁹⁴ The travel time will be restricted as to not interfere with heavy traffic. The time restrictions are between 5:00am to 8:30am and 3:00pm to 6:00pm.²⁹⁵

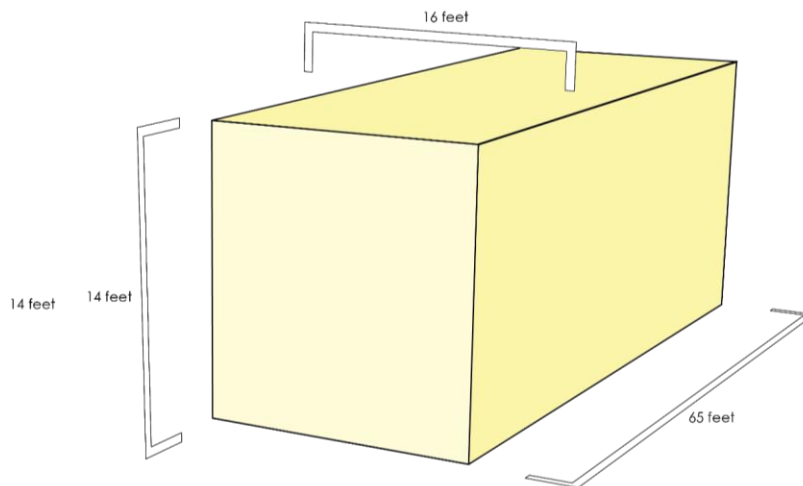


Figure 30 Diagram of Maximum Transportation Size

²⁹³ "Oversize/ Overweigh Permit Manual Hawaii," The Specialized Carriers & Rigging Association, accessed March 23, 2017, <http://permits.scranet.org/wp-content/uploads/2015/05/Hawaii.pdf>. 2.

²⁹⁴ Ibid. 3

²⁹⁵ "Oversize/ Overweigh Permit Manual Hawaii," The Specialized Carriers & Rigging Association, accessed March 23, 2017, <http://permits.scranet.org/wp-content/uploads/2015/05/Hawaii.pdf>. 4.

The proposed accessory dwelling unit is designed to be transportable. Most of the furniture and fixtures are built in and remain intact during the move, to ease the stress caused by removing personal items and shipping them to another home. The dwelling unit is not intended for frequent moves. It is projected to move approximately three times, in its lifespan. The first move will transport the unit to the single-family home lot. The second move may be to relocate the unit to the community site. The final possible transport could be removing the unit from the community site to another destination. Since the unit may move infrequently, it will be designed wider than nine feet, but within the sixteen-foot maximum, to provide more interior space and comfort. Therefore, the dimensions of the transportable accessory dwelling unit must not be larger than sixteen feet wide, fourteen feet tall, and sixty-five feet long.²⁹⁶ The proposed unit will require a permit and escort for transport.

7.2 Accessory Dwelling Unit Requirements

For these transportable units to be applicable as accessory dwelling units, one must understand what an accessory dwelling unit is and what the requirements are.

“An accessory dwelling unit (ADU) is a home, built on a single-family lot, separate from the main dwelling. Accessory dwelling units have their own kitchen, bathroom, and sleeping facilities. They can be attached or detached from the existing single-family home, also called the primary dwelling unit. Accessory dwelling units are sometimes referred to as granny flats or in-law apartments, both names referring to multi-generational living. They can be completely new construction, an extension or partition of the main house, or a conversion of an existing accessory structure such as a recreational room or garage.”²⁹⁷

A single-family home lot must be in a residential or country district and the lot size must be at least 3,500 square feet, to be eligible. The land cannot be blocked by another home and must have vehicle access and a parking stall. The maximum floor area for a lot

²⁹⁶ Ibid. 2.

²⁹⁷ "Accessory Dwelling Unit Homeowners' Handbook: A Guide for Homeowners on Oahu Interested in Building an Accessory Dwelling Unit," Hawaii Appleseed: Center for law & Economic Justice, accessed October 12, 2017, <http://hawaiiadu.org/wp-content/uploads/2016/10/ADU-Manual-ver.-4-FINAL.pdf>, 1.

size of 3,500 square feet to 4,999 square feet is 400 square feet. For a lot that is 5,000 square feet or larger it can be up to 800 square feet.

7.3 Design Vision

The design intention of the Transportable Accessory Dwelling Unit is to provide adults with a living environment that allows for subtle physical and mental stimulation. Being physically active each day to prevent the onset of ailments that commonly occur with aging are addressed in in the design aspects of the interior and exterior features of the housing structure, as well as the planned community. The design features of the home will support the active participation of the occupant's healthy lifestyle that benefits their physical and mental health. As mentioned in Chapter 4 of this document, physical activity, socialization, and horticultural therapy are ways in which to promote healthy lifestyles.

The design of the home promotes physical activity using simple adaptable moving interior furniture. The task of pulling and pushing keep elderly moving to perform everyday tasks. The furniture supports activity more so than what happens in a normal home environment, as the function of the furniture is focused not only on usability but on physical activity. At the same time, it is important to keep the movable furniture pieces simple and inconspicuous, as to not make the action seem like a chore.

Another important element in healthy aging is focused on strengthening memory. Lack of mental stimulation, as adults age, can lead to not only mental health issues, but also physical ailments. Therefore, providing a few moving elements within a home, requires a person to consciously perform tasks, indirectly stimulating the mind.

Aging is not just a time of deterioration, instead it is a time in which to reflect on their full lives (reference Chapter 3.4.2 of this document.) As individuals age, they reflect on the different events they attended, cities they have travelled to, and people they have met or come to know. Most people have many items they have collected or photos of family and friends, which they would like to display. Therefore, providing an element within the home that displays personal items is very important, as discussed in section 3.4.2. These items become a part of a person's identity and are conversational pieces for

visitors. Personal artifacts are the elderly's connection to their past, whether it is a place they miss, or a person whom is no longer with them.

Another element that provides mental stimulation is horticultural therapy. As discussed in Chapter 4.3, horticultural therapy has been proven to reduce stress and improves cognitive abilities. Therefore, an additional goal is to provide a few simple architectural or site elements in which elderly can easily participate in gardening on a small or large scale.

The furniture of the accessory dwelling unit promotes healthy habits and behavioral habits that stimulate memory. Over the span of a person's lifetime, habits formed within the home and neighborhoods are comforting. Moving to a new environment disrupts routines and habits and can be traumatic and stressful, which is only exasperated as one grows older. Chapter 3.4.1, of this document, provides a more in-depth account as to why this happens. Therefore, a way to reduce the trauma of moving out of your home is to move the accessory dwelling unit. A Transportable Accessory Dwelling Unit can be moved from the home to a community designed to house the ADU and provide support for the needs of aging residents. This form of housing could be viewed as a new way to age-in-place.

This design can be used as a prototype for Transportable Accessory Dwelling Unit, for any single-family home lot that meets the State of Hawai'i's requirements for building accessory dwelling units on properties.

7.3.1 Design Requirements for Accessory Dwelling Unit:

Based on the research presented in Chapters 1-5, of this document, this next chapter will explain the design proposal for the transportable accessory dwelling unit, that will promote healthy aging in Hawai'i. The proposal combines key elements from the precedent studies found in the previous Chapter 5, such as adaptable architectural features, small and transportable home features, and ways to combine the accessory dwelling units in a community setting. This proposed design is based on this writer's point of view. There are many ways that the research can be interpreted and this is just one design to address the issues mentioned in this document.

Most suburban homes on Oahu feature simple wood framed construction. The proposed design of the accessory dwelling unit will blend modern architectural features such as flat roofs and metal window shading devices with more traditional features such as window treatments and materials, etc.

To address the physical ailments that one might develop as they age, this next section will explain the individual design elements for the proposed accessory dwelling unit that will be incorporated to make the unit, a safe and comfortable environment.

As mentioned in Chapter 3.2.1.1 of this document, as one ages, mobility issues may develop. To address this issue, the floor areas of the home must be clear and accessible. To make the home accessible to everyone, all rooms within the home will have a minimum turning radius of five feet to allow for wheelchair accessibility. If residents develop mobility issues, the five-foot turning radius will address this problem. To have easy wheelchair access to the sinks in the kitchen and bathroom, there will be no cabinets under the sinks. The proposed unit must also have sufficient storage for personal items, to keep the floor free of clutter and reduce the possibility of tripping. The width of the unit is also larger than the most transportable units. By widening the unit, it allows for easier accessibility and an improved interior environment.

Adjustable and multi-purpose furniture within the unit will help to promote daily physical activity, as well as maximize the small square footage. An example of a moveable element is a sliding or rotating partition. These furniture elements are easy to move but require a physical interaction with the owner. This design idea based on the Yume No Mizumi Mura Facility in Japan, was discussed in Chapter 3.2.1 of this document. Instead of having space free barriers, the proposed space will have intentional barriers that require physical strength to operate and thus, address the strength and fitness loss that commonly occurs with aging. Through these simple movements, the muscles and well-being of the elderly are improved. Some examples of moveable elements found in the precedent studies of Chapter 5, of this document, are rotating and sliding walls, furniture drawers for storage, multi-functioning storage elements, and pull down wire shelving for upper cabinets. This will help reduce accidents from heavy falling elements. There are also existing kitchen appliance lifts for heavy equipment stored on bottom

shelves. These features do not limit the amount of physical movement, but help to alleviate some of the strain. The proposed elements will be discreet and will not seem like a daily burden but be part of routines in the daily life in the home.

The loss of dexterity and sense of touch can make simple everyday activities more difficult. Simple tasks such as opening a door can be difficult because the shape of the typical round door knob makes it hard to grasp. All drawers and doors will have easy to open handles, such as a lever handle, discussed in Chapter 3.2.1.3 of this document.

Incontinence is another common issue that many older adults face. It can be embarrassing and may limit participation in activities due to the anxiety of the inability to control the bladder. Therefore, despite the limited size of the accessory dwelling unit, a bathroom will be centrally located in the home to allow for easy access from all areas.

The unit will not have an air conditioning system, however, providing enough windows to allow for cross-ventilation will help residents to control the temperature. There will be windows that can be left open at the top to allow for constant

Figure 31 Kitchen Appliance Lift

Source: "Granberg Unilift Kitchen Appliance Lift," Living Made Easy, accessed March 10, 2017, <http://www.livingmadeeasy.org.uk/kitchen%20and%20household/accessories-for-accessible-kitchens-p/granberg-unilift-kitchen-appliance-lift-0105892-2417-information.htm>

Figure 32 Pull Down Wire Shelving

Source: "Vibo Pull Down Two Tier Wire Shelves," Living Made Easy, accessed March 10, 2017, <http://www.livingmadeeasy.org.uk/kitchen%20and%20household/kitchen-shelves-and-platforms-p/vibo-pull-down-two-tier-wire-shelves-0112747-3883-information.htm>

air flow, and reduce the stress of safety and privacy. Another feature that will be incorporated is shading devices for the windows. The optimal orientation for the unit is to have a North-South orientation for both sunlight and wind, however, the unit can be oriented any direction. A way to mitigate strong sun, with poor orientation, is to provide sufficient vegetation to shade the home.

Eyesight and vision have a tremendous impact on everyday life. To allow for easy visual distinguishing between spaces and elements, the furniture elements will be made of wood to contrast with the white walls.

While there are many other physical ailments that one may develop with aging, these are the features that were focused on for the design of the transportable accessory dwelling unit. Although these elements are commonly addressed in documents about aging in place, it is also important to create home environments that promotes cognitive health.

Over the span of a person's life, the accumulation of various mementos and photographs from events and people are collected. These items take on significant meaning in old age, because often the people are no longer here or the places are too far to travel to. The items begin to represent part of a persons' life, and their history. The items become a form of identification and are used as conversational pieces for guests, as well as, items to reflect on. This topic is covered more in depth in Chapter 3.4.2 of this document. Since items play a large role in the identity of many older adults, the proposed accessory dwelling unit, will have several ways to display their items.

As people age in their homes, they become attached to their environment and the habits that they have established. The attachment to a habitual routine makes it difficult to move. The suburban and rural neighborhoods of Hawai'i are not designed to support elderly and typical aging in place due to the lack of accessibility to amenities within a walking distance. As mentioned previously, those who no longer drive have a difficult time completing daily tasks such as going to the grocery store, the bank, or even to the doctor's office. As mentioned in Chapter 4.2 of this document, those who no longer

drive, make 15% less trips for medical appointments and 65% less trips for religious, social, or community activities.²⁹⁸ This is very relevant in Hawai'i and can affect the well-being of many isolated elderly. Therefore, the proposed accessory dwelling unit design is transportable, to allow the resident to move the location of their unit, but remain within the comforts of their own home. This reduces the amount of change to the daily routines. Change will occur as the home is located within the new accessory dwelling unit community.

Socialization is key for both physical and mental health. Within the accessory dwelling unit, it is difficult to promote socialization, however the unit will have an additional guest bed for family and friends to come and visit. As mentioned in Chapter 5.3.2 of this document, the use of wood furniture and personal mementos can help to reduce stress and promote socialization in elderly. Therefore, the furniture and interior finishing materials will be light birch wood. Light wood is used to keep the space feeling lighter and more open, versus darker colored woods.

Another feature that will be incorporated into the design is an element to promote horticultural therapy. Since the unit is small, the planting elements will be simple and multi-purpose, make access to gardening easy for the user. These are all features that apply elements from the research to the design of the accessory dwelling unit.

7.4 Proposed Accessory Dwelling Unit

Design

Based on the requirements listed in the previous section and the requirements of the accessory dwelling units in Hawai'i, the unit contains a full kitchen, bathroom, washing machine, and bedroom. The added elements for the unit are a front patio and a reading nook. The accessory dwelling unit has elements that relate to the main topics of the research: elements that

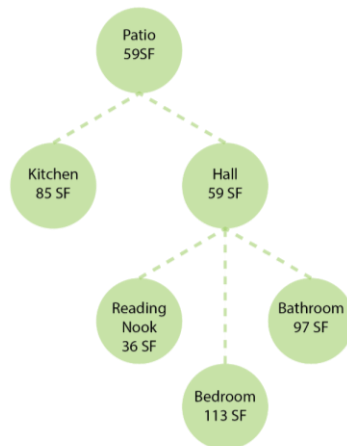


Figure 33 Spatial Diagram of Rooms & Square Footage for Proposed ADU

²⁹⁸ Lehning, "City Governments and Aging in Place: Community Design, Transportation and Housing Innovation Adoption." 2.

promote social activity, elements that promote physical activity, elements that display memorabilia, elements that promote horticultural therapy, and elements to allow for easy transportation. This section will explain the different elements for each topic. Figure 33 is a bubble diagram of the spatial organization of the progression of rooms within the unit. The spaces are organized from public spaces to more private spaces, with the bedroom as the last area to be reached. The bathroom is in the center, located across from the reading nook to allow easy access from all areas of the unit.

As mentioned in the previous section, all spaces require five feet wide access to allow for wheelchair accessibility. Since the bathrooms are one of the most accident-prone spaces in homes of elderly, the bathroom space is expanded by the sub-volume extruding out on site. Wheelchairs can turn around within it. Bathtubs can be difficult to enter and the unit will feature a shower with a seat. There is also ample storage. The washing machine is behind a wooden partition within the bathroom. The vanity has no cabinets underneath to allow for wheelchair accessibility. There are windows located above the shower and toilet to allow for ventilation.

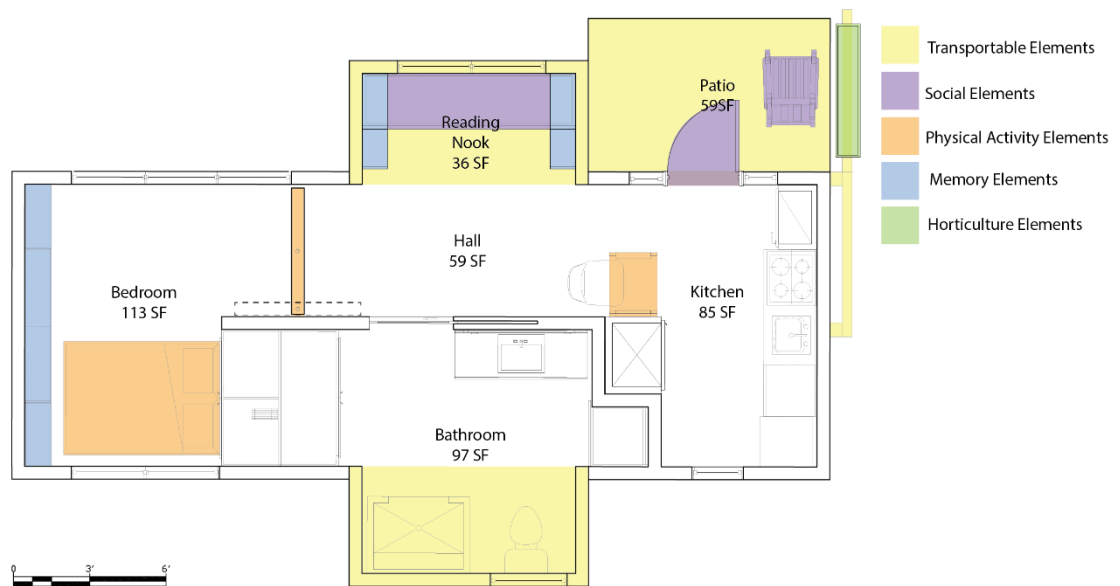


Figure 34 Floor plan Displaying the Transportation, Social, Physical Activity, Memory and Horticultural Elements

7.4.1 Physical Activity Design Elements

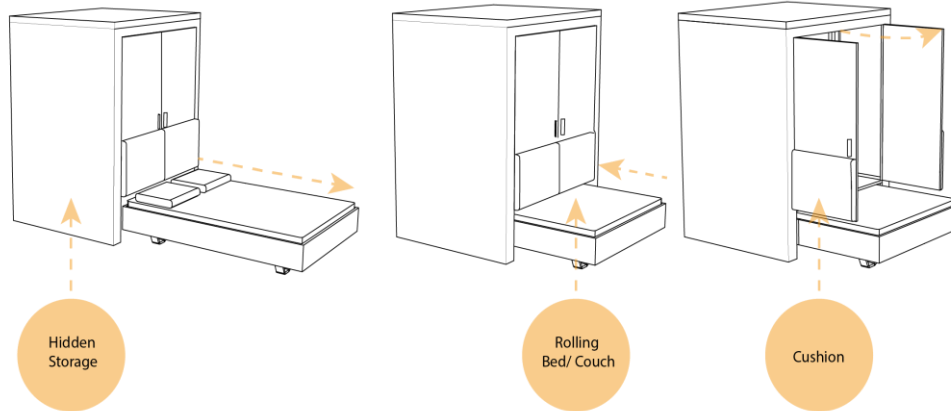


Figure 35 This Diagram Highlights How the Bed System Moves

As discussed in Chapter 4.1 of this document, physical activity is one of the most common preventative activities for physical and mental deterioration. Universal design aims to reduce all barriers that may inhibit easy access of both public and private buildings.

While this makes environments much safer, it also reduces the amount of opportunities for physical activity.

The unit therefore combines ideas from both barrier-free residential design and intentional barriers to promote physical movement. In Figure 34, the elements highlighted in orange are elements that require movement for transformation. These elements are simple and do not require too much energy, however they still require one to use basic muscles.

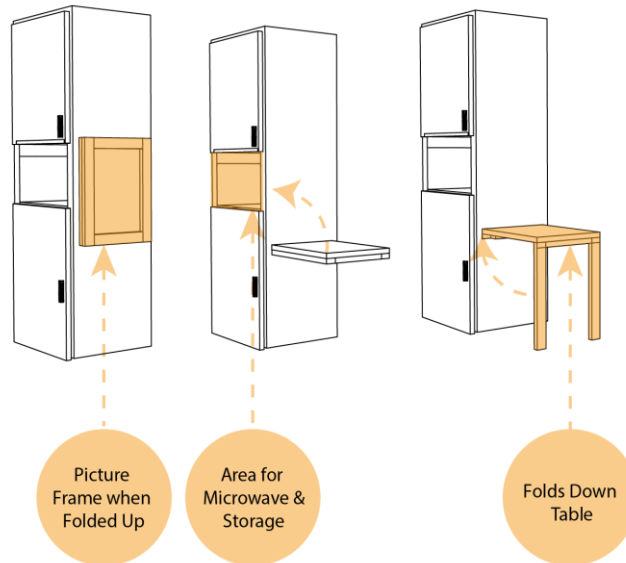


Figure 36 Diagram of Picture Frame That Transforms to Table

The bed system is a custom bed and storage system. The bed slides underneath the shared split closet system used for both the bedroom and bathroom. By sliding the

bed partially under the closet, the bedroom has more room. Additionally, when pushed in, the bed becomes a couch. Figure 35 highlights the elements of the design. The doors for the closet have built in cushions for comfort when used as a couch, while also acting as a headboard for the bed. The simple movement of pushing and pulling the bed out will work the user's muscles.

The next component within the unit that promotes physical activity is the picture frame that folds down to a table. It is attached to the kitchen closet, that also houses the microwave. The picture frame table helps to save space and requires physical movement to pull or push to table into position.

When the table is not in use, it serves the function of a frame for the user's choice of artwork. This is another way in which their memorabilia (a picture or painting) can be displayed.

The final element that promotes physical activity is the sliding partition between the hallway and bedroom. The partition rotates and slides to sit against the wall of bathroom, when more space is needed. To enter the bedroom, the door rotates the same way, as if you were to push it to the side. Compare Figure 36 and 37. These moving elements do not require a lot of effort to move. However, the simple movements will prevent residents from becoming too sedentary.

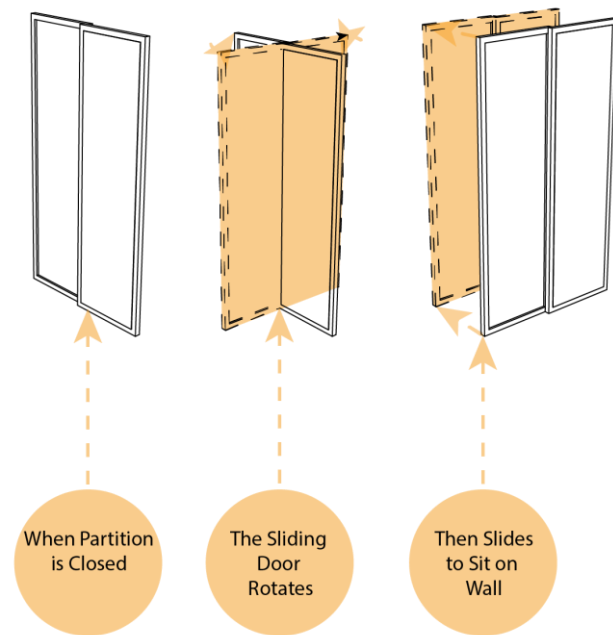


Figure 36 Highlights How the Door Between the Bedroom and Hallway Slides and Rotates

7.4.2 Memory Design Elements

Throughout a lifetime, many souvenirs and items are collected that represent times and places in one's life. A house becomes a home when the space is personalized with their items and habits that are established within the space. The proposed unit provides two areas for displaying the resident's mementos. While there are many

different existing modern modular shelving systems, the design for the unit shelving is kept simple as not to distract from the items themselves. These displays are highlighted in blue in Figure 38. The shelves are adjustable to allow flexibility to the number and height.

The first of the two display elements are the shelving system along a wall in the bedroom. The system has three features: modular shelves, tall storage with doors for personal items they may not wish to display, and rolling lower cabinets. The modular shelving system is very commonly found to help keep costs low. The cabinet system reaches the roof to maximize storage. Within the higher cabinets, the pull-down wire shelves would help to have safe and easy access to items. The owner of the accessory dwelling unit could choose to have either solid wood cabinet doors, or partial glass cabinet doors.

The second item that displays a person's effects is the shelving system in the reading nook. The day bed has a twin mattress and can also be used as a guest bed for when friends or family visit. The open shelving lines both surrounding walls. The built-in

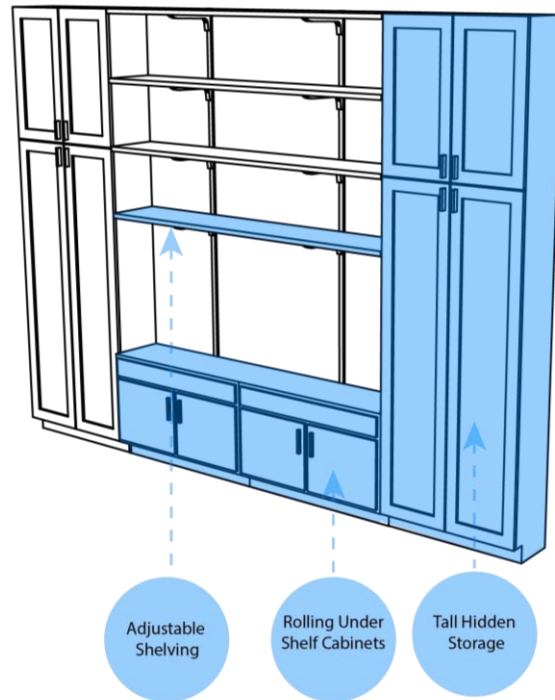


Figure 38 Diagram of Shelving System to Display Collectables

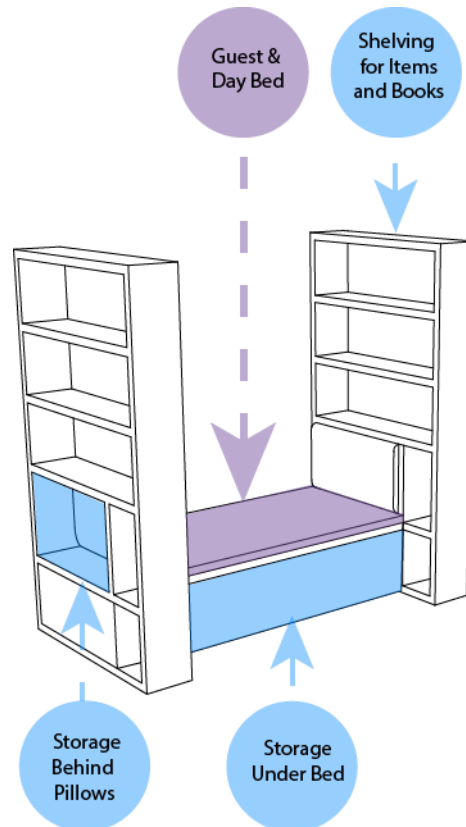


Figure 39 Diagram of the Memory and Social Features of Day Bed

cushions located along the shelving system fold down and items can be stored behind them. The bed mattress, opens to allow for additional storage such as blankets and larger personal items. The reading nook is in one of the sub-volumes that extrudes out of the unit when placed on site. It has a large window to allow for the resident to enjoy looking out to the garden. These elements of both hidden and display storage are highlighted in blue in Figure 39. While both displays, features are simple, they serve their function, while keeping costs lower than other more modern shelving systems.

7.4.3 Social Design Activity

Elements

Another activity that has therapeutic qualities is social interactions. While this activity can also have negative responses, many older adults do not have enough social interaction which can lead to depression and isolation. For more information on the importance of socialization refer to Chapter 4.2 of this document. Within the small unit, it is difficult to promote socialization, however three simple elements do so subtly.

The first of the purple highlighted elements in Figure 39, is the day bed. As mentioned in the previous section, it is multi-purpose for storing items, displaying mementos and book, and providing a guest bed. When visitors come, they can sit on the day bed and talk, or stay the night. The centralized location of the day bed also promotes socialization.

The next element that was chosen to promote social interaction is the Dutch front door. The door is split in two and the top can open independently of the bottom half of the door. This feature gives a sense of security, allows for the breeze to flow through, as well as, promote social interactions. The door is solid wood to provide security.

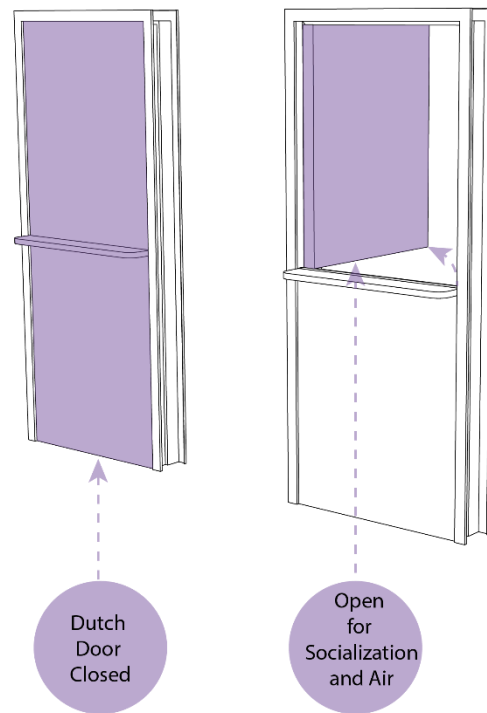


Figure 40 Diagram of Dutch Doors

However, its ability to open, lightens the heaviness of the door to allow for interaction to the outdoors.

The last element that promotes socialization within the accessory dwelling unit is a rocking chair on the front porch. The porch space gives the resident to option to go outside of the unit, observe and interact with the neighborhood. The choice of a rocking chair versus a regular seat chair was purposeful. By having the ability to rock while sitting, one is typically more likely to sit outside longer because of the rhythmic constant movement. It has also been known to have many therapeutic physiological and psychological effects. “Thus, the use of platform rockers as a safe, practical, and nonlabor intensive source of relaxation and improved physical and psychosocial well-being, as well as improved balance, should be explored. Rocking chair therapy represents a promising new innovative non-pharmacological approach to improving the quality of life of dementia residents in nursing homes.”²⁹⁹ This was taken from a small study on its effects. While it is not large enough to obtain substantial evidence, it does provide support in rocking chairs use. The ability to ease emotional distress is a great reason to have rocking chairs. While they can be stereotypically associated with elderly, there is a good reason for their long history and research has proved it.

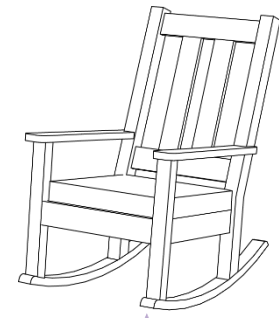


Figure 41 Rocking Chair Allows for Resident to Sit on Porch & Socialize

7.4.4 Horticulture Design Elements

The last section for therapeutic activities is horticultural therapy. As discussed in Chapter 4.3.2, there are various health benefits of horticultural therapy. For additional information on the benefits, refer to Chapter 4.3 of this document. This element is kept simple to allow the resident to choose how much gardening they wish to conduct. The front porch shading device allows for the planters to be hung from the horizontal metal framing. The shade also helps to allow for easier access to plants by raising them above

²⁹⁹ Watson, Nancy M., Thelma J. Wells, and Christopher Cox, “Rocking Chair Therapy for Dementia Patients: Its Effects on Psychosocial Well-being and Balance,” *American Journal of Alzheimer’s Disease* (1998): 307.

the ground height. This reduces the amount of bending down necessary to care for the plants. The planters are one foot wide, four feet long, and one foot tall. The dimensions are larger to reduce the amount of necessary daily care. The smaller the planter, the more care is needed. Depending on the owner, additional pots of various sizes can be selected. The flexibility of the number of planters, gives the owner control over their environment. An additional horticultural element within the unit is to add potted plants. Irrigated green walls and roofs were not including because they can be expensive. The goal was to create simple design features that would not be costly to maintain.

There are also various companies that offer indoor and outdoor systems for growing gardens. Ikea offers an indoor gardening system that will allow anyone to grow their food within their kitchen. IKEA's indoor hydroponic system is great for those on land.³⁰⁰

Depending on the site that the accessory dwelling unit is placed, there may be other opportunities for horticultural activities. Building elements that are made for gardening can be costly, so one of the most cost efficient ways to promote horticultural therapy is to look at the site in which the unit is placed on. The site area will provide much more square footage for gardening opportunities. The ways in which to benefit from horticultural therapy as previously discussed in Chapter 4.3 of this document,

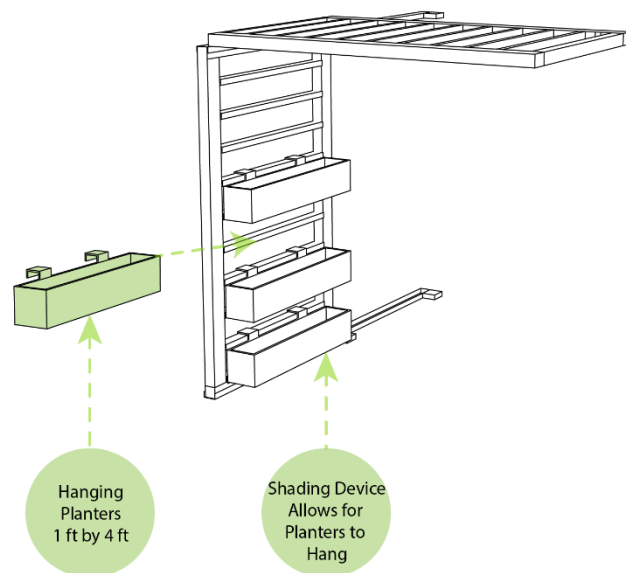


Figure 42 The Exterior Porch Shading Device Allows for Planters to be Hung

³⁰⁰ "Grow Kit W 30 Pots, 3 Tiers: Krydda/Vaxer," IKEA, accessed March 3, 2017, <http://www.ikea.com/gb/en/products/indoor-gardening/indoor-growing-cultivators/krydda-vaxer-grow-kit-w-30-pots-3-tiers-spr-19158689/>

require the stimulation of all five senses. Through the plant choice one can achieve this sensory experience.

7.4.5 Adaptable Transportation Design Elements

Based on the maximum transportation size for oversized loads, the unit is designed to be twelve feet wide, thirty-one feet long, and ten feet tall, when in transportation mode. However, to increase the size of the unit, the bathroom and reading nook are in sub-volumes that extrude when placed on site. When the unit is being transported, the sub-volumes are pushed in to allow for road transportation. This concept was inspired by the Lot-ek Shipping Container Home, discussed in Chapter 5.3.1 of this document.³⁰¹ With the sub-volume units extruding out on-site, the unit is twenty feet wide, which is four feet wider than the maximum width allowed while in transportations. Figure 43 is a diagram of transformation of the massing. The porch is the other element highlighted in Figure 43. It folds down on-site and connects to the site foundation.

Another adaptable feature of the transportable accessory dwelling unit, is the porch shade near the entrance of the unit. The top of the shade is detached from the support that connects to the extruded sub-volume. The hanging planters are removed, and then the top shade folds down. The shading panels slide into a slot attached to the left façade of the unit. The adaptable elements help to reduce the time and effort needed to

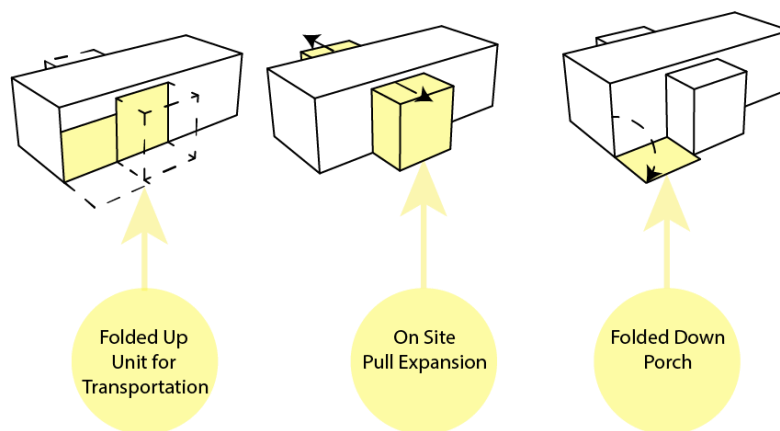


Figure 43 Diagram Highlighted Showing How Massing Changes From Transport Mode to On-Site

³⁰¹ “MDU (Mobile Dwelling Unit),” Lot-Ek, accessed November 10, 2016, <http://www.lot-ek.com/MDU-Mobile-Dwelling-Unit>.

move the unit to another site. By designing built-in elements that consolidate the elements together, it makes transporting the unit simple.

For the sub-volumes to slide into the larger volume, the finished flooring is raised to the height of the floor of the sub-volumes. It is removed for transportation and reinstalled after placed on site. The section cut that is gray, is the sub-volumes within the

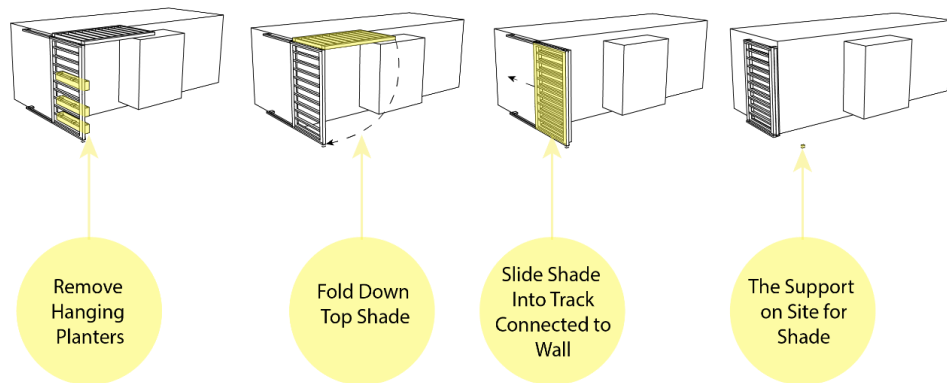


Figure 44 Diagram of How the Exterior Shade Slides for Transportation

main unit volume, shown as a black section cut. The finished floor is the thin section cut in black right above the gray sub-volume in Figure 52.

7.4.6 Modular Structure

To make the unit flexible and allow for expansion or reduction in size, the accessory dwelling unit structure is a steel framing with four by ten-foot wall panel in-fill. This modular design accommodates easy and flexible construction. As seen in Figure 45, the steel framed sub-volumes are set within the larger steel frame volume. While this modular design is not exactly like Traditional Japanese Architecture, as mentioned in Chapter 5.1.2-5.2.3 of this document, it uses a framing and in-fill system, like the wood structure and shoji screens. Although using wood is the preferred structural material because of its renewability, its lifespan and the difficulty of making modifications to it, make steel the preferable material. The ability to attached and detached steel and still retain structural strength make it appropriate for a transportable unit. The design of the sub-volumes will need more research prior to construction. While the concept is like Lot-ek Shipping Container Home as seen in Chapter 5.3.1 of this document, their actual construction methods are unknown since the information is not available. Full-scale models would be beneficial in finding a successful construction system that would be

both structurally sound and waterproof. The entire accessory dwelling unit is a type of module that can be inserted into an existing permanent structure.

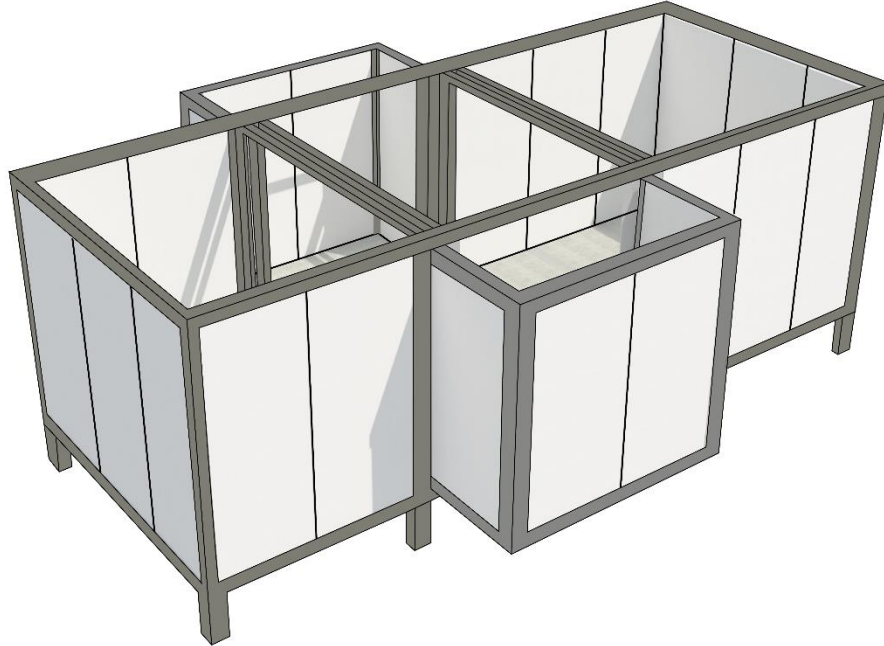


Figure 45 Diagram of Modular 4x10 Foot Wall Panel System

7.4.7 Summary of Unit Design

The design of the transportable accessory dwelling unit is the designer’s opinion on how to apply the research of Chapter 1-5 to an actual design. The design is still within the conceptual design phase. The next steps would be to determine costs, materials, sustainability, and preparing construction documents and details. Utilizing future sustainable options that would allow the accessory dwelling unit to go off the water and electrical grid could make the units more affordable in the long run and exponentially increase the success of this project.

However, the intention of this document is to bring attention to finding new ways that we can address the housing issues in Hawai’i especially for elderly. Many people do not think about how the design of their homes will affect their well-being as they age. The goal is to bring attention to designers and even home owners to know that a homeowner’s needs may change overtime because of physical and mental ailments that

occur as one ages. Designers should be conscious that their proposed design may not be appropriate for the homeowners twenty years later. Therefore, they should either design homes that will function at any stage of life through barrier-free design, or provide flexible elements that allow for easy modifications.

Another important factor that designers should consider is investigating interdisciplinary fields for information on how to improve architectural designs. Through the understanding of how aging affects one's mental and physical well-being from a medical standpoint, a designer will have a clearer understanding of how the home environment would be used. Through this and research one may come across new therapeutic activities to promote a person's well-being. These elements could then be integrated into the design of future homes.

In the next section of this document, the application of the transportable unit will be applied to a single-family home lot. The purpose of this is to show how the unit can be integrated into the site.

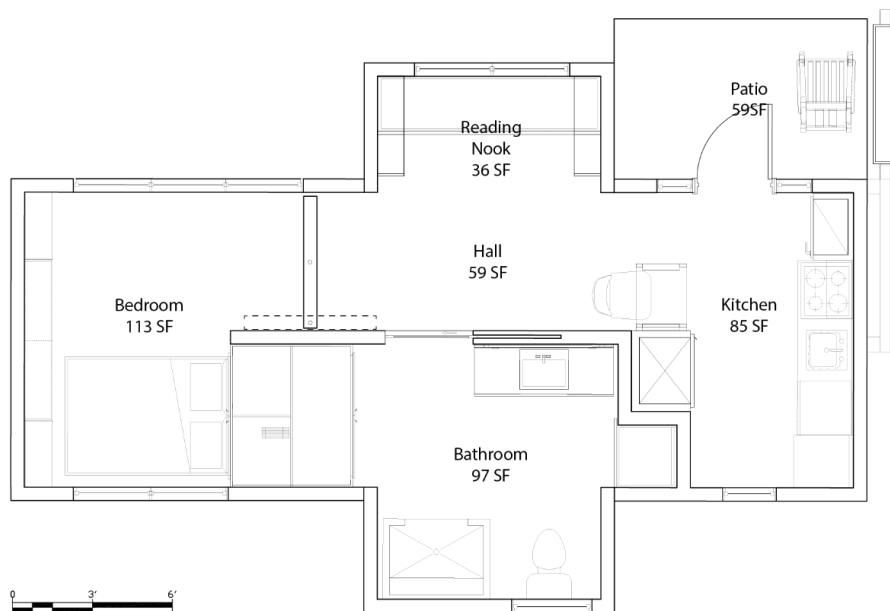


Figure 46 Floorplan of Proposed Additional Dwelling Unit



Figure 47 Accessory Dwelling Unit Elevations



Figure 48 The Front of Proposed Transportable Accessory Dwelling Unit

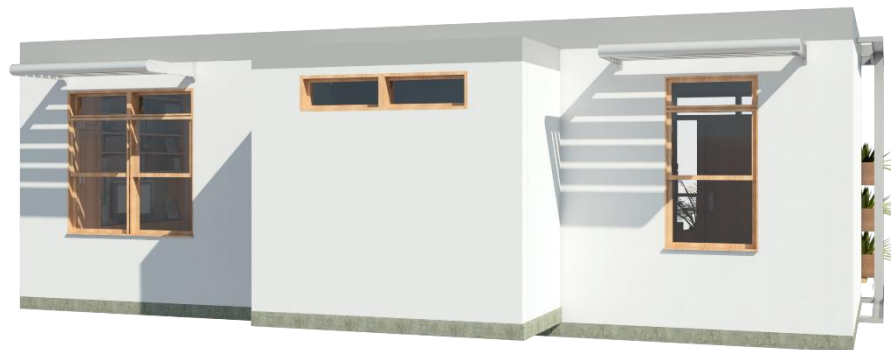


Figure 49 The Back of the Proposed Transportable Accessory Dwelling Unit



Figure 50 Section Perspective Through Sub-Volumes to See How They Fit Inside Unit for Transportation



Figure 51 Exterior Rendering of Sub-Volumes Pushed-in for Transportation



Figure 52 Section Perspective Through Sub-Volumes to See How They Fit Inside for Transportation



Figure 53 Interior Rendering of Unit from Bedroom: Shows the Bed Pulled-out and Rotating Wall Open



Figure 54 Interior Rendering of Unit with Bed Pushed-in and Rotating Wall Closed



Figure 55 Interior Rendering of Kitchen with Picture Frame Table Folded Away



Figure 56 Interior Rendering of Picture Frame Table Folded Down



Figure 57 Interior Rendering of Memory Wall in Bedroom



Figure 58 Interior Rendering of Reading Nook & Front Door



Figure 59 Interior Rendering from Kitchen Looking Towards Front Door

7.5 Integration of the Transportable Unit into Single Family Home Lot

7.5.1 Site Selection

As mentioned in Section 5.1.1, the law allows single family home lots, that meet various requirements, to build an accessory unit on the property for long term rental. However, the estimated 15,098 properties that may be eligible to accommodate an ADU, are still required to obtain the approval of various departments based on wastewater capacity, adequate available water supply, fire department safety requirements, and that

traffic review meet the minimum road conditions. The zoning must also be within the residential zones: R-3, R-5, R-7.5, R- 10, R-20, or country district. The zoning, lot size, minimum square footage, and parking requirements are the only readily available information on the eligibility for a property to have an accessory dwelling unit.

The water, sewer, fire, and traffic requirements are assessed after the application is processed. Therefore, for this dissertation, the site selection for a single-family home lot for the proposed unit, will be based upon the steps prior to applying for the ADU, and it will be assumed that the property meets the latter requirements.

To find a site that is appropriate for an accessory dwelling unit, the zoning of the island of Oahu was investigated. Another important document is the map of the elderly population location, collected from the 2010 Census, through the GIS system. This map displays that elderly seem to prefer to live in south eastern Oahu, areas such as Honolulu, Hawai'i Kai, Kaneohe, etc... As mentioned in section 1.2, it has been discovered that there are naturally occurring retirement communities (NORC). These areas have 40% or

more of the residents of 60 years and older. The five NORC's on Oahu are within: Manoa, Punchbowl, Mo'ili'ili, Kaimuki, and Kaneohe areas. Manoa, Punchbowl, Mo'ili'ili, and Kaimuki are closer to the city of Honolulu and have higher opportunities for easy access to amenities. Therefore, the community of Kahalu'u, near Kaneohe was the site selected for implementing

Table 1 Selected Site Information

Source: GIS Hi Central

Site Information	
Address	Kahalu'u
TMK	4705212
Land Area (sq. ft.)	11,026
Land Area (acres)	0.2531
Square Footage	1,540
Number of Floors	
Year Built	1974
Bedrooms	3
Full baths	3
Framing	Wood/ single wall
Property Class	Residential
Assessed Land Value	\$537,900
Assessed Building Value	\$239,200
Total Property Assessed Value	\$777,100
Zoning	R-5
Height Limit	25'

the accessory dwelling unit on a single-family home lot. It was selected because it is a suburban area that is not a walkable community, which is like many other suburban neighborhoods on Oahu.

The website walkscore.com rates a site based on walkability to these categories: dining and drinking, groceries, shopping, errands, parks, schools, and culture and entertainments.³⁰² The website rates sites from: 0-24 very car dependent, 25-49 car dependent, 50-69 somewhat walkable, 70-89 very walkable, or 90-100 walker's paradise. For the selected site in Kahalu'u the walk score was a five, very car dependent.³⁰³

When an individual develops memory, sight, or mobility issues, driving can be dangerous for everyone. Therefore, many elderly stop driving. Since Hawai'i is very car dependent, this can lead to isolation and depression. Some choose to catch the bus. The bus however, requires more travel time, which can be exhausting. Hence, the travel time, for walking, driving, and the taking the bus, from the site to basic amenities was analyzed. The selected site meets all the basic requirements for eligibility for an Accessory Dwelling Unit. The site has a large open yard on the southern side of the site. Based on actual distance, the selected site is not far from many of the amenities, however, if the individual takes the bus, the time is significantly longer than driving. For elderly who no longer drive, a walk score of five, from *walkscore.com* is not an easily accessible community.

Another way the site was analyzed was based on the time it takes to reach important amenities. These times are taken from the Google Map estimations.³⁰⁴ The selected site, in Kahalu'u, has very easy access to the bus stop, however, the time to travel doubles or triples by bus, compared to travelling by vehicle. Refer to Table 2 of this document for more information.

³⁰² "Walk Score: Live Where You Love," Walk Score, accessed March 20, 2017, <https://www.walkscore.com/score/46-alaloa-st-kaneohe-hi-96744>

³⁰³ Ibid.

³⁰⁴ "Google Maps Directions from 46-68 Alaloa Street," Google, accessed March 3, 2017, <https://www.google.com/maps/place/46+Alaloa+St,+Kaneohe,+HI+96744/@21.417381,-157.8081322,17z/data=!3m1!4b1!4m5!3m4!1s0x7c006afed6ac8357:0xdaaeb3f708c59565!8m2!3d21.417376!4d-157.8059435>

The times collected from Google Map for walking, may take even longer for elderly. For someone who needs just one item from the store, this can be an exhausting trip. Selecting this site for the example of site integration of the transportable accessory dwelling unit, will show how only the location of the unit affects the well-being of the resident.

Table 2 The Estimated Time to Important Amenities by Walking, Vehicle, or Bus

Source: Google Maps

Amenities	Walk	Vehicle	Bus
Grocery Store	21 minutes	4 minutes	29 minutes
Park	33 minutes	4minutes	37 minutes
Hairdresser	21 minutes	4 minutes	29 minutes
Healthcare	1 hour 7 minutes	7 minutes	18 minutes
Mall	1 hour 7 minutes	7 minutes	18 minutes
Church	1 hour 15 minutes	8 minutes	19 minutes
Drug Store Pharmacy	1 hour 21 minutes	11minutes	26 minutes
Bus Stop	1 minute	1 minutes	0 minutes
Police Station	1 hour 19 minutes	10 minutes	24 minutes
Fire station	1 hour 19 minutes	10 minutes	24 minutes
Library	1 hour 19 minutes	10 minutes	24 minutes
Recreation Center	29 minutes	3 minutes	23 minutes
Senior Center	1 hour 43 minutes	14 minutes	40 minutes

7.5.2 Existing Site Conditions

The selected site is located on the Windward side of Oahu. The Windward side is known for frequent rain and lush vegetation. It has beautiful views of the Ko’olau mountains, which are West of the site. The Ahuimanu stream runs behind the home, adjacent to the large yard on the southern side of the home, which is visible in Figure 60. The site has a slight slope down towards the Northern side of the site, see Figure 62. It sits on alluvium, which is fertile soil that is found in flood plains and is deposited by flowing water, see Figure 61.³⁰⁵ The prevailing wind comes from the North-East and the sun rises in the East, and sets in the West. The sun is strongest on the Southern side. The

³⁰⁵ “Alluvial Soil,” Vocabulary.com, Accessed March 20, 2017, <https://www.vocabulary.com/dictionary/alluvial%20soil>

best orientation to optimize the wind and reduce sun exposure, is North-South. This way the unit will have great cross-ventilation. The existing home has parking on the Northern side on site as shown in Figure 63.

The existing home is elevated by two-feet with a covered veranda on the South and East face of the building. There are stairs from the sidewalk to the elevated veranda for pedestrians. A vehicle can also access the large yard on the Southern side of the site, through the break in vegetation. The site has a significant number of trees bordering the edges, that provide both shading and privacy. From personal observation, the home owner enjoys using their large yard and wishes to keep as much open as possible. To do so, the unit will be located closer to the existing home. The current elevated veranda needs to be redone because of deterioration and wear. Therefore, the unit will be connected to the existing home through a new elevated deck, as seen in Figure 64.

Most of the new deck will be located closer to the street side of the site, with a cut-out to leave existing trees, as well as, provide privacy to both the accessory dwelling unit and the original home. The existing stairs are also very narrow, so in the new



Figure 60 Site Location Highlighted in Yellow

proposal the stairs would be widened to allow for easier access.

The Southern side of the site, still has a great deal of open yard space. The proposed decking wraps around the Eastern side of the unit, to allow for easy access to the yard. A ramp will provide easy access to the elevated deck. The area in Figure 64, with the large stones allow for one vehicle to park with loading space on each side of the car. The accessory dwelling unit, will sit on a pre-installed pillar foundation to elevate the floor to the height of the elevated deck.

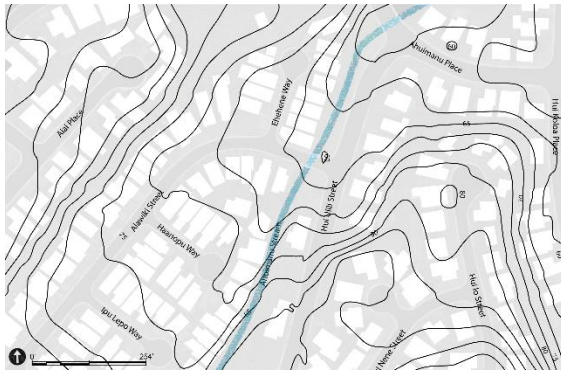


Figure 61 Terrain Lines with the Site Sloping Down Towards Top of Image

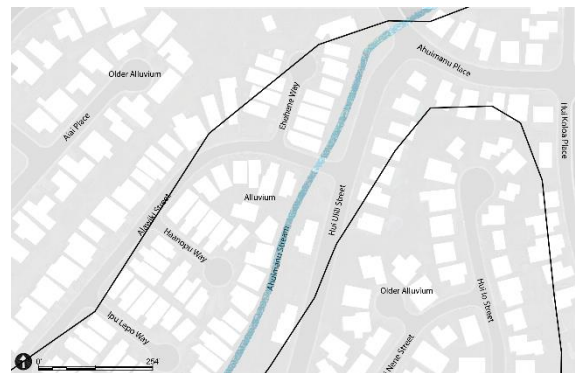


Figure 62 Site Soil Information

Figure 66 shows how the unit would look with the new deck and enlarged stairs from the street. As mentioned the Ko'olau mountains are very close and provide a beautiful backdrop for the unit. The unit will allow the homeowners to obtain income from renting either the unit or the main home out. After a few years, the initial investment for the accessory dwelling unit would be paid off. As mentioned in the beginning of this section, the location of this home is very isolated, with no close amenities. When the homeowners are no longer able to drive, they have the option to move their unit to a community site for easier everyday access to amenities. By having proximity to amenities, it also promotes residents to walk instead of driving, thereby, increasing their physical activity, which is one of the goals of this document. The next section of this Chapter is the site selection and design proposal for the Community site. This Community site will provide more opportunities for physical activity, socialization, and horticultural therapy, which are the main therapeutic activities to lead a healthy lifestyle.

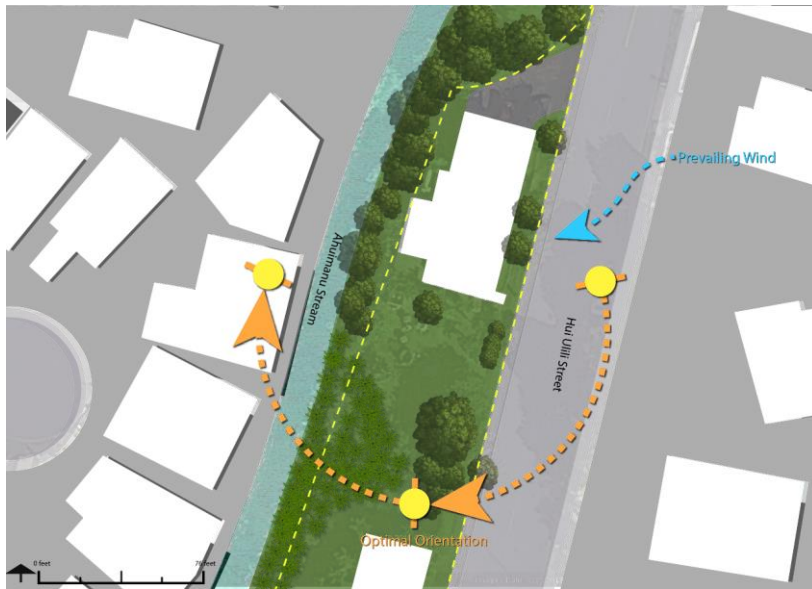


Figure 63 Existing Site Conditions with Prevailing NE Wind



Figure 64 Site Plan for Accessory Dwelling Unit Integration into Site



Figure 65 Rendering of the Decking that Connects the Unit and Existing Home with Shared Seating



Figure 66 Exterior Rendering of Unit and Original Home from the Street

7.6 Integration of the Transportable Unit in Community Site

7.6.1 Site Selection

Of the five areas with naturally occurring retirement communities, only one is on the eastern side of the Ko'olau mountains. When looking at the map of the areas with the most elderly, Kaimuki and Kaneohe were the two of the naturally occurring retirement communities that were analyzed for their possibility for the site selection. The sites that had the largest square footage were the selected sites for consideration. Single family home lots were not considered, because of their small square footage and they are more difficult to obtain for re-development.

In Chapter 1.4, respondents to an AARP survey of people over 45 years and older focused on all the factors that affect the elderly in Hawai'i's needs such as: community and health features, outdoor spaces and buildings, transportation, housing, employment, social participation, communication and information/ community resources, and respect and social inclusion. The survey showed that location to amenities, social events, and easy access to transportation were needed.³⁰⁶

Accessory Dwelling Units are most commonly found in less dense areas such as suburban neighborhoods, or country districts. These areas have additional land; in which they can build another unit. However, these suburban and rural sites are typically a far distance from amenities, and require many to drive to go to the grocery store, bank, and so forth. This becomes increasingly more difficult as people age, and some may choose to move closer to amenities and city centers. Moving can be a traumatic experience, and if you are moving to an area that is very unfamiliar, such as a dense city, from the country, it can be very difficult to adjust. For the people on the East coast of Oahu, many do not have close access to amenities. Those living in Kahau's, Palau's, Kajawah, etc... must drive far distances for basic supplies. Providing a community site in a neighborhood or area with a similar environment will be more comfortable for newcomers.

³⁰⁶ Brittne M. Nelson and Eowna Y. Harrison, *Livability for All: The 2014 AARP Livable Communities Survey of Honolulu, Hawaii Adults Age 45+*, accessed November 15, 2016, http://www.aarp.org/content/dam/aarp/research/surveys_statistics/il/2014/liveability-for-all-the-2014-livable-communities-survey-of-Honolulu-Hawaii-adults-Age-45-plus-aarp-res-il-pdf.26.

The city of Kaimuki is a suburban community that provides many amenities along the main road of Waialae Avenue. There is a lot redevelop in the area and many old buildings are gaining new life. The linear quality of the community, can be difficult to walk, seeing as it is spread out much farther, then other typical communities. The suburban areas are also hilly and difficult to walk.

The city of Kapolei, consists of mainly agricultural lands. However, a lot of the land is being develop, and there are many single-family home lots. The population of Kapolei is composed of younger families, but the site was considered because of the development occurring and the possibilities of planning and building walkable communities exists. Today, the community is still very spread out and requires a car to get from place to place, making it unsuitable for elderly. Nevertheless, in the future, it may become a possible location of a new community site.

The last city analyzed is Kaneohe, on the Windward side of the island. This city consists of mainly single-family home lots, town houses, and a few mid-rise apartment buildings. While the residential community is very spread out, the amenities are concentrated near each other. For those who use the proposed accessory dwelling unit on their properties along the East coast of Oahu, would be more comfortable because of the familiarity of the natural surrounding landscape. While this community site is located on

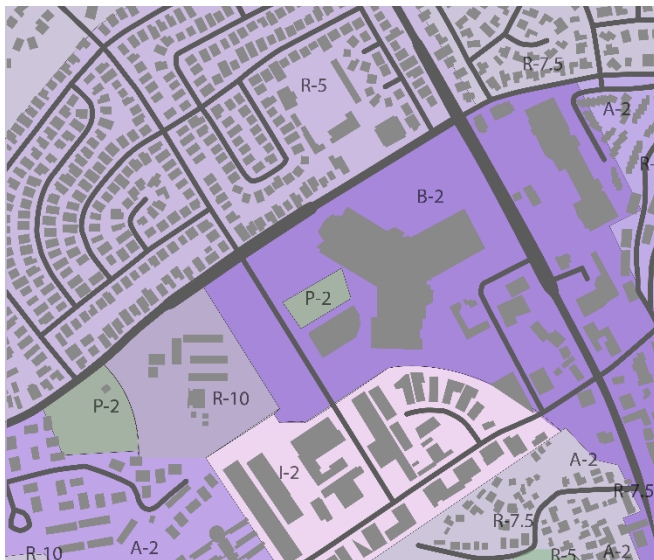


Figure 67 Map of Existing Zoning for Kaneohe Town

the Windward side, the goal is to have more than one community site available on the island of Oahu, providing a variety of communities to choose from. Those in more urban areas might have more stories, while those near a hillside or mountainous terrain might have a terraced appearance. Hence, the design for the community site is a unique design created

school within only five minutes walking time. Therefore, the score should be above a seventy-five, making it an appropriate site for older adults. Figure 68 maps out the closest amenities to site.

When looking at the estimated times for walking to amenities, the greatest times were to walk to the police station, fire station, library, recreation center, and senior center. The police station and fire station do not need to be directly next to the site if they have a close enough distance for quick response, which would be around four minutes by driving. The walking distance from the site to the existing Kaneohe Senior Center is approximately a thirty-minute walk or six-minute car ride. This however, will not be an issue, because the proposed site will have a senior center incorporated. The location of the site directly across from Windward Mall, is very positive for the elderly because of all the stores, restaurants, activities, and healthcare providers within one centralized area. It also provides an enclosed, cool space to walk, when it is too hot outside. There are also many elderly groups that gather in the large interior courtyard to talk, sing, and play ukulele together. The location of the site is important for the residents because the main reason for moving the transportable accessory dwelling unit is to be closer to a high concentration of amenities.

Table 4 Estimated Travel Time from Community Site to Walk, Drive, or on the Bus to Amenities

Source: Google Maps

Amenities	Time to Walk	Time to Drive	Time on Bus
Grocery Store	9 minutes	3 minutes	5 minutes
Park	5 minutes	1 minutes	4 minutes
Hairdresser	5 minutes	2 minutes	Walking Distance
Healthcare	3 minutes	1 minutes	Walking Distance
Mall	2 minutes	1 minutes	Walking Distance
Church	4 minutes	1 minutes	Walking Distance
Drug Store/ Pharmacy	10 minutes	3 minutes	4 minutes
Bus Stop	1 minutes	1 minutes	0 minutes
Police Station	16 minutes	4 minutes	8 minutes
Fire Station	16 minutes	4 minutes	7 minutes
Library	16 minutes	4 minutes	8 minutes
Recreation Center	20 minutes	4 minutes	19 minutes
Senior Center	32 minutes	6 minutes	18 minutes



Figure 68 Map of Amenity Location

7.6.2 Site Analysis

The community site is a very long and narrow area. The shape and orientation of the site make typical North-South orientation difficult with all units. The number and location of the existing trees also make it difficult to create a cohesive design. Therefore, some trees will be saved and others, moved to new locations on the site. The South-West edge of the site borders He'eia Elementary School. That edge has large mature trees creating a nice barrier between the sites. Those large trees also provide significant shading for the South-Western edge of the site. Figure 71 illustrates the existing trees on site. He'eia Elementary is at a higher elevation than the proposed community site. The boundary between the two sites slopes down towards the community site. This slope provides more privacy for residents of the community site, as well as, even more shade

from the hot afternoon sun, shown in Figure 71. This shade will help make up for the lack of North-South Orientation of all the units. However, at least half of the units will be oriented North-South. All units will be able to take advantage of the prevailing wind because of the narrow width and large windows. This will help residents to remain cool.



Figure 69 Map of Sloping Terrain

Figure 70 Map of Soil Types



Figure 71 Site Plan of Existing Conditions of Community Site with Sun & Wind

7.6.3 Design of Community Site



Figure 72 Bubble Diagram of Proposed Layout of Site

For those who wish to bring the transportable accessory dwelling unit to the community site, they will have more opportunities to engage in the therapeutic activities that were described within Chapter 4, of this document. While, the design of the individual units aimed at creating interior environments with elements that promoted these activities, the community site will do so, as well, but on a larger scale. The community center will be located towards the center of the site to provide a relatively equal walking distance from each end of the site. There will be three neighborhoods within the site. Instead of one large neighborhood, the smaller communities will allow for more intimate opportunities for interaction. The units will be staggered to provide both privacy and interesting courtyard spaces, for each neighborhood. Taking advantage of the large existing trees that are on the border with He'eia Elementary, a pedestrian street will be located along this boundary. Pedestrians and vehicles will be completely separated to provide a safe environment for physical activity. One of the goals is to integrate the greater Kaneohe community into the site with the community center having various shops. The name of the community is Ke Alanui O Nā Kānaka, which translates to, the

People's Street. The reasoning is because the community has a pedestrian only street connecting the neighborhoods which promotes socialization and physical activity. The community is not just for elderly, but all ages and the name should reflect this.

7.6.4 Transportation to the Units to Site

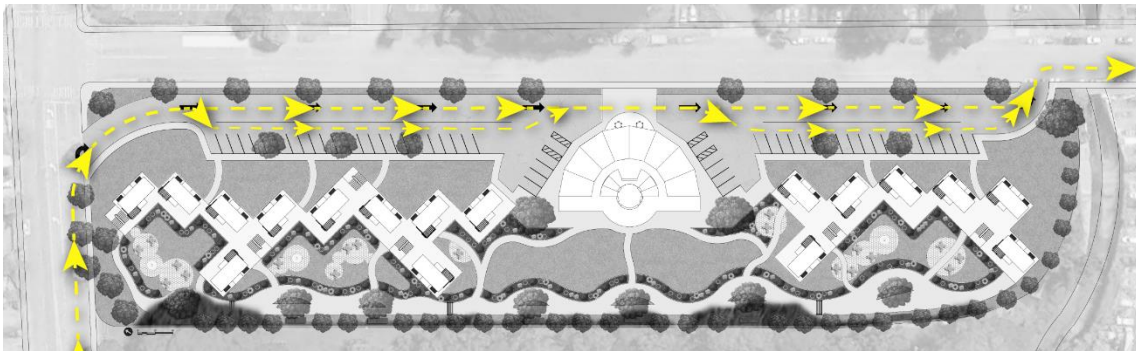


Figure 73 Diagram Showing Vehicular Access to Site in Yellow

As discussed in Chapter 5.4, Metabolic Architecture was a movement that believed the urban landscape is composed of both permanent and impermanent elements.³⁰⁸ The proposed transportable accessory dwelling units are the impermanent elements that can move from their single-family home lots to the community site, the permanent element, the community site. Metabolic architecture was usually composed of megastructures that were mid-to-high-rise buildings. This type of building not only does not match the Kaneohe community as there are very few mid-rise buildings. Also, as the number of floors in the building increases, the time and costs to install and remove units becomes much more difficult. Therefore, the proposed design is only two stories, with the possibility of three stories. Figure 73, depicts how the units sit on an existing structure and the vehicular access. The community site will have a steel and concrete structural system to support the second story units. The units will be transported from the single-family home lots by a semi-trucks and low-boys. A small crane will be used to hoist the unit into place. The interior courtyards are lined with raised planter boxes. To make the space flexible, and to provide easy access to all units for transportation, the raised planters are composed of smaller sections. This will allow the planters to be moved

³⁰⁸ Zhongjie Lin, "Nakagin Capsule Tower: Revisiting the Future of the Recent Past," *Journal of Architectural Education* 65, no. 1 (2011): 16.

inserting a new unit. To limit the disturbance to the community, there will only be two days a year in which units can be moved in or out of the site. This will also reduce the number of times a crane is necessary. Parking access will be from Haiku Road and exit on Alaloa Street. This removes the necessity for a turnaround area for vehicles and keeps the main pedestrian road and vehicles separate. There is a parking stall for each unit and guest parking located near the community center. Pathways connect the parking stalls to the units. The design of the site is not only based on the transportation of units to the site, but also the three main therapeutic activities for a healthy lifestyle, described in Chapter 4, of this document.

7.6.5 Physical Activity

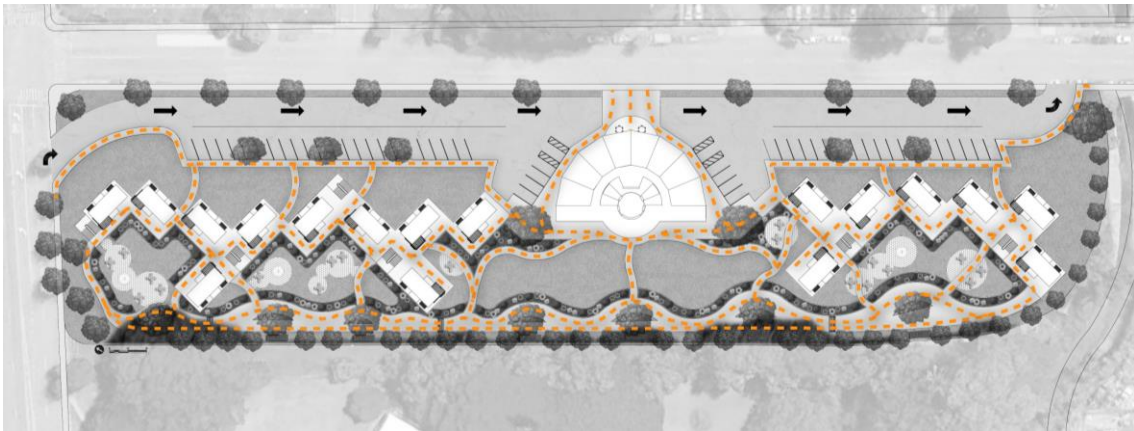


Figure 74 Diagram of Pedestrian Circulation in the Community Site

The first therapeutic activity that is integrated into the site design is physical activity. With the design of the accessory dwelling units being very small, the amount of physical activity within the unit is limited. Hence, the surrounding site provides a better chance for exercising. As mentioned in the previous paragraph, there will be a pedestrian street along the South-Western boundary of the site. To promote walking at the site, the pathways are designed to be wide enough for residents in wheelchairs to pass each other, as well as, provide frequent seating areas. The edge of the pedestrian street closest to the elementary school is a straight line and the other edge is a meandering path with trees interspersed. This is visible in the rendering of Figure 74. The two types of edges allow for pedestrians and bicyclists to pass each other safely. There are benches located on the straight edge of the pedestrian street to provide a shaded spot to rest from exercising, or to watch the passerby's. As people age, some may develop memory issues and

disorientation. While this community is not specifically designed for dementia patients, each neighborhood has a distinct courtyard layout to provide landmarks for orientation. The neighborhoods are also marked along the pedestrian street by a gateway trellis to designate the entrance. Residents walking along the pathways will learn the names of the neighborhoods, which are designated by signage and can meet other residents in the community. This is depicted in Figure 83. This community is not for just elderly, but older adults that wish to age within a community that promotes healthy lifestyles. Even though there are three different neighborhoods, all the units are connected by a staggering pathway.

The units are stacked two stories tall to provide a higher density of units and maintain a significant amount of open space on the site. Residents who are more mobile will be located on the second floor, which is accessed by stairs. This will promote physical movement and the prevention of muscle atrophy. However, the units on the bottom floor are for those who deem stairs dangerous or too difficult to climb. This provides the community with people of different abilities to promote social interaction.

7.6.6 Social Interaction

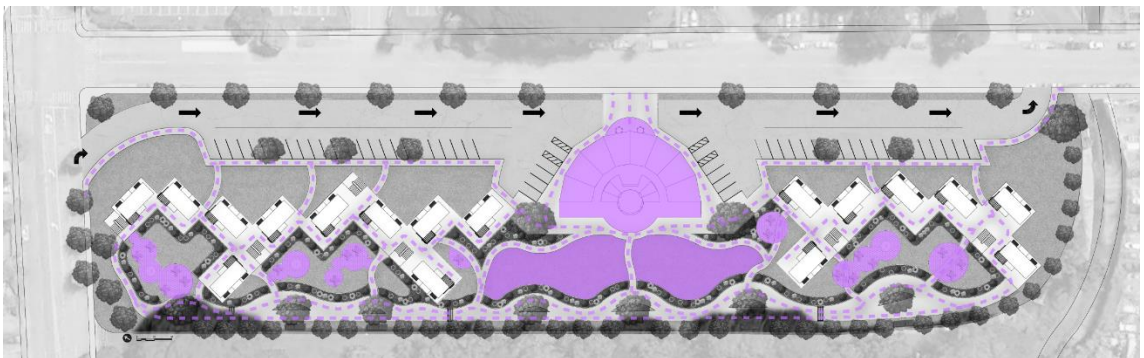


Figure 75 Areas for Social Interaction in Purple

Social interaction is the next therapeutic activity necessary to lead a healthy lifestyle. The whole concept of a community site is to provide more opportunities for social interaction. Living in the unit alone, in the suburban areas of Oahu can be isolating and one of the main reasons to bring the unit to the site. Organization of the site is designed to promote social activity. The staggering of courtyard spaces provides areas for the residents of the neighborhood clusters to congregate. Each cluster has several tables

with shade to provide space for everyone. The courtyard areas are designated by a paving in different circular formations and are each unique. The design depends on the size and shape of the courtyard. The open lawn space at the center of the site near the actual community center provides enough area for not only residents, but outside community members to congregate for events. These include, but are not limited to: outside movie viewing, farmer’s market, outdoor exercise classes, painting or drawing classes, horticultural therapy classes and many more. By providing a large open space next to the community center, it allows for flexibility of the site and uses of the space. It also is a nice area for the visiting children of He’eia Elementary and Saint Ann’s Model School to interact with the residents.

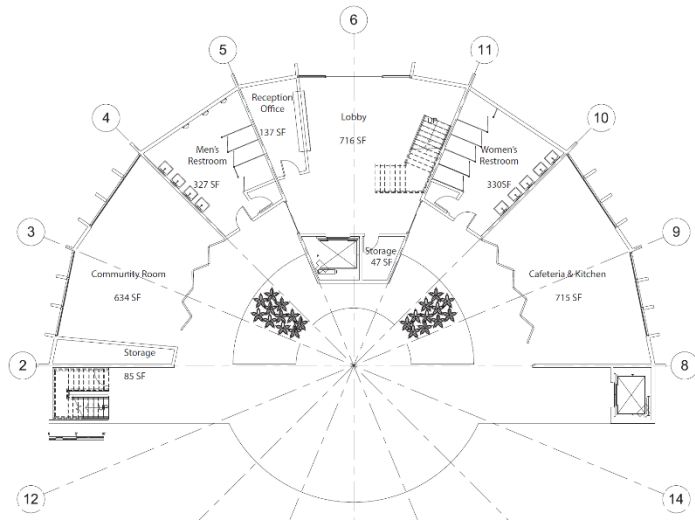


Figure 76 The Layout of Ground Floor Community Center

Physical activity and socialization go together. They, typically promote each other. Thus, the pedestrian street not only promotes physical activity, but provides opportunities for meeting new people or talking with old friends.

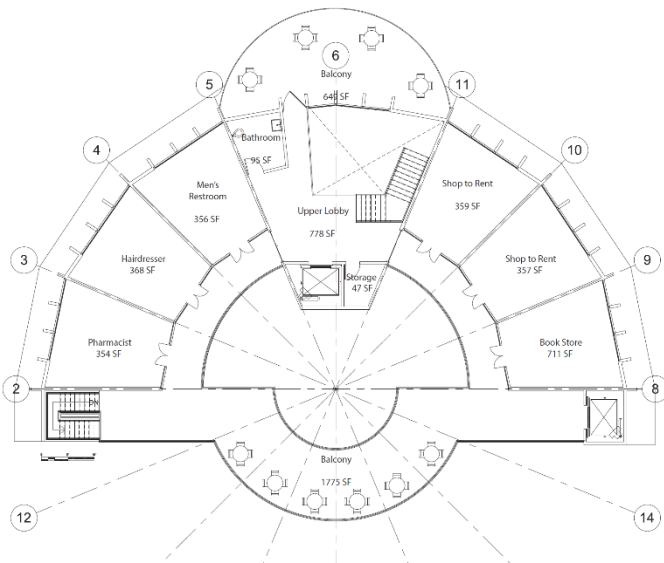


Figure 77 The Layout of the Second-Floor Community Center

Within the site, one of the main features is the Community Center. The shape of the building is a semi-circular shape with a patio space on the second floor overlooking the open lawn area. The bottom floors have the lobby,

restaurant/café, and the community room. Both the restaurant/café and community room have interior walls that completely open to the interior courtyard. The large restrooms are located on the bottom floor. However, the second floor has one handicap stall for those who do not want to go to the first floor.

On the second floor are five shops that anyone can rent. The sixth shop is for residents to sell their fresh produce, artwork, etc.... The suggested shops for the Community Center are a hairdresser, book store, bakery, do it yourself pottery studio, and daycare center. There will also be areas to engage in games such as Bingo and cards, viewing areas for television, and vertical gardens. These however are just suggestions for ways to bring the outside community to the site. As mentioned, the second floor has a large covered balcony to look over the open lawn space and watch the various events or activities. When looking at the second level floorplan, in Figure 77, you can see the elevator shaft at the center of the building. The exterior wall closest to the interior courtyard is purposefully left blank to allow for projections to be displayed. On the second floor above the street entrance there is also a balcony space to look out over the street side. See Figure 87 street-side rendering, and Figure 86 for section perspective through the building. The stairs and elevator towards the street side of the building are intended more visitor use. The stairs and elevator towards the open lawn area are for site residents. By providing commercial opportunities within the site, it not only involves individuals outside the community, but also helps to reduce the cost of living. The income obtained from renting the shops out and the community room for events, assists with the maintenance of the facility and possible help to reduce unit rental costs. Through the pedestrian oriented community, courtyard sitting areas, and large community center, residents will have many opportunities to meet new people and engage in interesting activities within their own neighborhoods.

7.6.7 Horticultural Therapy

Natural environments can provide a sense of healing and promote healthy lifestyles. As mentioned in Chapter 4.3 of this document, it can provide both mental and physical benefits. There are essential elements that are necessary for a garden to provide healing and promote stimulation of our five senses. According to the book, *Landscape*



Figure 78 Areas for Horticultural Therapy in Green

and Urban Design for Health and Well-being: Using Healing, Sensory and Therapeutic Gardens, there are ten elements necessary for a garden to be considered a “healing garden.” They are: light and shade, a view, comfortable seating, textural detail, water, accessible features, wildlife- birds and bees, cultural references, personal references, and scale.³⁰⁹

Light and shade, are very important to the sensory experience of an environment. Those who develop sensory deficiencies as they age, become sensitive to environmental changes. However, these environmental changes, such as sunlight and temperature, provide them with a sensory experience. The change from light to shade can provide a way-finding element for those who visually impaired.³¹⁰ The contrast of light and shade, provide viewers a sensory experience. This experience can be aided by shading from trees or man-made shading devices. These two types of shade have very different experiences. Shade from trees provide an ever-changing shaded environment. As the wind blows through the trees, the branches move, changing the position and shape of the shadow cast on the ground. “Views up through a gently moving tracery of leaves are hard to match within a manufactured environment.”³¹¹ The shade cast from a tree is also typically much cooler than a man-made structure, because of transpiration of water through the tree’s leaves.³¹² Even though natural shade provides many benefits, the man-

³⁰⁹ Gayle Souter-Brown, *Landscape and Urban Design for Health and Well-Being : Using Healing, Sensory and Therapeutic Gardens* (Abingdon, Oxon : Routledge, 2015), 218.

³¹⁰ Ibid. 218.

³¹¹ Gayle Souter-Brown, *Landscape and Urban Design for Health and Well-Being : Using Healing, Sensory and Therapeutic Gardens* (Abingdon, Oxon : Routledge, 2015), 219.

³¹² Ibid. 219.

made shade structures are much quicker to install.³¹³ The man-made structure also requires less maintenance, and defines space in a very clear and pragmatic way. Light and shade is integrated in the design of the Community site, with both man-made and natural elements. Utilizing the existing trees on the border of the site, provides a shaded walking path. Within the neighborhood courtyards, the tables are provided with umbrellas. The choice of these smaller man-made devices, is to allow for flexibility within the courtyard. Larger shading devices would be difficult to move. Tables and umbrellas are much less difficult.

When designing the garden, it is important to remember to design *a view or safe vantage point*. As mentioned in Chapter 4.3, a view of nature through the window has health benefits. Thus, providing areas or seating to view nature will reap benefits despite the vantage point. The feeling an environment gives depends on the amount of open to closed space ratio. “A distant view from an elevated position is uplifting. In an enclosed setting the view is inwards and upwards to the sky, so sight lines must account for this.”³¹⁴ The benches along the pedestrian street provide, dynamic and active vantage points, because of their proximity to physical movement. In contrast, the neighborhood courtyards, may provide a quieter more contemplative environment. This is due to the elevated planters creating a semi-enclosed space. It also has less pedestrian traffic because it is not directly located on the pathway. This provides a more calming space.

To make a vantage point enjoyable, *comfortable seating* is necessary. This does not only account for the material of the actual chair or bench, but the environment it is in. Providing seating areas allow for introspective contemplation. The balance of physical activity with rest is important both mentally and physically. Seating can provide people with rest. The environment will affect the feeling of the space. An area that is more enclosed, with less pedestrian traffic may be more calming than a seat along the main pedestrian path of a site. By placing seating around a site, it promotes physical movement. “In public spaces wherever people gather, outside schools, local shops, community centers, at 30-50 meter intervals on established walking routes, it is important

³¹³ Ibid. 219.

³¹⁴ Ibid. 220.

to provide seating.”³¹⁵ The seating within the community site varies. The benches along the pedestrian street, are hard wooden benches. Since this is a more active sit, the bench materials do not promote long periods of sitting down. However, in the courtyard, the seating is much different. The chairs come with a table, meaning it has a dual purpose. It is not only used for a brief resting moment, but for lunch, or meeting with friends.

Another key element to healing natural environments is *texture and surfacing*. Within the environment there needs to be various types of textures to stimulate the senses and create a connection to nature. Textures can be found not only in the pavement material, but the types of plants or trees used in the landscaping. The surfaces should provide visual and textual interest; however, they should be relatively smooth as to not become a trip hazard. “Texture is used in reflexology parks in Canada, Malaysia, Korea, Japan, and elsewhere in a very controlled way to create wellness gardens. On a barefoot path at Bad Sobernheim in Germany, reflexology stimulates the whole body through the transition over grass, clay, sand, stones, and bark chips.”³¹⁶ The variation in materials keeps the interest of users longer than single material design. The texture throughout the site varies. The steel and concrete of the unit structure are very smooth and clean. The pedestrian street is a smooth pebbled street This provides such texture variation, but a smooth surface to reduce accidents. The grassy lawns provide a contrasting soft texture in a much harder environment.

Water is an important natural element that should be designed into the site. Whether it is utilizing collected rainwater or a permanent water fountain, water stimulates several senses at once, thus providing a calming effect. Depending on the type integration it can provide different emotions.³¹⁷ Water is integrated in simple water fountains located in each neighborhood courtyard. The water features are all circular with a wooden seating rim, to promote interaction with the water.

³¹⁵ Gayle Souter-Brown, *Landscape and Urban Design for Health and Well-Being : Using Healing, Sensory and Therapeutic Gardens* (Abingdon, Oxon : Routledge, 2015),226.

³¹⁶ Ibid.229.

³¹⁷ Gayle Souter-Brown, *Landscape and Urban Design for Health and Well-Being : Using Healing, Sensory and Therapeutic Gardens* (Abingdon, Oxon : Routledge, 2015), 229

Accessibility is the next section necessary for healing gardens. This is essential because everyone must have accessibility to use healing gardens and to reap their benefits. It is unfair to design a garden for only one specific type of person. Especially since, they are typically public spaces or community gardens. Accessibility is very important when designing for aging. Even though elements throughout the design promote physical activity, the elements must be designed with more detail to make them safer. For example, the stairs are typically considered a negative barrier, when discussing accessibility. However, this is the reason the units on the ground floor are reserved for people with mobility issues. This gives them accessibility, while also promotes physical movement, using stairs, in those residents who are still independently mobile.

Wildlife is a natural feature that is attracted through the choice of vegetation. By integrating flowering plants, it will attract butterflies, birds, bees, and other insects. Seeing wildlife increases the sensory experience and can be a distraction to negative aspects in life.³¹⁸ Wildlife is a difficult element to design architecturally. This aspect can be done by creating habitats or through the selection of plants.

The next necessary element for healing gardens is providing a *cultural reference*. Through garden design people can be reminded of their location in world. Cultural reference will make users more present in their environment.³¹⁹ This can be done through the integration of native plants, signage, or sculptures. Cultural references are integrating into the site through the selection of native and tropical plants. Examples of plant selections will be discussed in the next section.

The second to last element is *personal reference*. This concept is straightforward. It is important to provide an area in which someone can claim as their own. This allows for participation in the garden and nature.³²⁰ A personal reference provides the opportunity for the horticultural therapy. If a landscape is over designed, it does not have flexibility and does not provide people with a sense of control over their environments.

³¹⁸ Ibid. 230.

³¹⁹ Ibid. 232.

³²⁰ Gayle Souter-Brown, *Landscape and Urban Design for Health and Well-Being : Using Healing, Sensory and Therapeutic Gardens* (Abingdon, Oxon : Routledge, 2015),232.

Each resident will be given a portion of the raised planter to grow whatever they please. It can be flowers or fruits and vegetables. This gives them the necessary personal reference within the landscape.

The final element is *scale*. Providing a garden space of human scale is necessary for the success of the project. If the scale is too large, it will make people feel small and disconnected from their environment. The urban environment is composed of large buildings and spaces. Consequently, there needs to be a balance of the scales. For vast open spaces, there should be smaller cozy areas for seating on the edge or dispersed throughout.³²¹ Scale is addressed in the community site through the different sized courtyards. The large open lawn can be intimidating to some. However, the small courtyards directly next to the lawn provide more intimate spaces for people.

These ten elements are important for the design of the landscaping of the community master plan. However, to benefit from horticultural therapy, the five senses must be stimulated. The Sensory Garden in Osaka, Japan, is a great example of the use of plants, materials, and features to create a sensory experience. The selection of plants is a remind of the climate, regional culture, and senses. It makes people present in their environment. Through gardening, a person feels a sense of accomplishment. The progress that is visible in a plant's grow provides this accomplishment. In the proposed community center, the horticultural program will teach residents how to care for plants, while also providing a free type of maintenance for the site's vegetation. The proximity to He'eia Elementary and Saint Ann's Model School is a great opportunity for a horticultural therapy program that brings together children and older adults. This will provide a necessary connection to the outside community, while also bringing together several generations. The next section is a selection of trees and plants that help to promote the stimulation of the five senses. These are just examples, and to further the landscaping design and plant selection, the consultation of a landscape architect could help to find proper combinations of plants to promote healthy environments.

³²¹ Ibid. 232.

7.6.8 Plant Selection for the Senses

This section provides examples of trees and plants that can stimulate the five senses. While each sense has examples for trees and shrubs, the example plants essentially stimulate more than one sense at a time. Therefore, the selected plants could be used in various ways.

7.6.8.1 Sight

Trees

Sight is one of the easier senses to be stimulated through nature. Just looking at a tree through a window helps to relieve stress, as mentioned in Chapter 4.3.³²² Yet, there are plants that are more visually interesting, such as colorful trees and plants. It is important to have a variety of color and sizes. Trees such as the *pink and white shower trees* are a smaller scale tree that blooms in June, April, or September. It is a very easy growing tree, that needs minimal management.³²³ It will remind residents of the seasons, while also providing a picturesque view.

The *yellow bird of paradise tree* is another plant with an interesting appearance in both shape and color. While it is typically thought of as a bush, it is classified as a tree and, grows to the size of a small tree. The flowers are light yellow and red. The shape of the flowers resembles the profile of a bird. These trees prefer full sun, and drier areas.³²⁴

Shrubs

Hibiscus come in many varieties of color and size. The yellow hibiscus is the state flower, and will provide a cultural reference. By providing a variation in type of hibiscus, it will be more visually interesting. They come in yellow, red, white, pink, and lavender.³²⁵

Pink or plume Ginger are an ever-blooming ginger plant. "The long inflorescence is made up of large, conspicuous, petal-like, rosy-crimson bracts. The true flowers

³²² Ruth Kjærsti Raanaas, Grete Grindal Patil, and Terry Hartig, "Health Benefits of a View of Nature through the Window: A Quasi-Experimental Study of Patients in a Residential Rehabilitation Center," *Clinical Rehabilitation* 26, no. 1 (2012): 21.

³²³ Loraine E. Kuck, *The Modern Tropical Garden : Its Design, Plant Materials, and Horticulture*, (Honolulu : Tongg Pub. Co., 1960), 83.

³²⁴ *Ibid.* 87.

³²⁵ Loraine E. Kuck, *The Modern Tropical Garden : Its Design, Plant Materials, and Horticulture*, (Honolulu : Tongg Pub. Co., 1960), 129.

appearing among these are small, whitish and hardly noticed. Stalks, from six to eight feet will bend gracefully making the plant useful as either a facer or a filler.”³²⁶ The bright colors and interesting shapes highlighted in these four examples give the necessary stimulation to the eye.

7.6.8.2 Taste

Trees

Plants that are edible are particularly great for horticultural therapy. They give an additional sense of accomplishment, because of the ability to eat their product. Trees that produce fruit can be both visually pleasing as well as, productive. The *breadfruit* tree has very ornamental leaves and it produces large textured fruit in spring and summer.³²⁷ This fruit can be very delicious, when cooked.

A *mango* tree is a large tree that produces the very popular fruit. The trees are very large, growing up to seventy feet tall. This tree, however, can be very picky for optimal climate for bearing fruit. If it is a particularly rainy year, the tree most likely will not fruit well. However, it has become a very popular snack in Hawai’i.

Shrubs

While the *papaya* tree is not a shrub, it typically small, and with pruning can be kept relatively short. It is both pleasant to look at, and produces a delicious fruit. “Large leaves, on long stems, coming out of the main stalk at right angles, make the lines of the tree strongly horizontal. Large, melon-like fruits, growing directly from the main stalk, also add an exotic appearance. It typically does better in drier climates, or very well drained soil.

Passion fruit is also not a shrub, but a vine. It produces delicious fruit used in salad dressings, jam, or just a snack. “The vines are woody, long-lived, large and high climbing, usually by tendrils. Foliage is full and lasting...The fruits are enclosed in a hard shell which withstands a fall to the ground, hence commercially they are not plucked, but allowed to drop.”³²⁸ The vine could be located where the stairs are in the community to

³²⁶ Ibid. 160.

³²⁷ Ibid. 91.

³²⁸ Loraine E. Kuck, *The Modern Tropical Garden : Its Design, Plant Materials, and Horticulture*, (Honolulu : Tongg Pub. Co., 1960), 96.

site, to be a visual landmark. These four examples are only a few of the many types of edible plants. Obviously, there are the typical vegetables and fruits that can be incorporated such as lettuce, cabbage, pineapple, etc.... Having a productive garden not only is great for horticultural therapy, but also a way to reduce the cost of living. By people growing their own food, it reduces the amount of food they need to buy. The large lawn in front of the proposed community center, could hold a weekly farmer's market. This would allow residents to sell flowers, fruits, vegetables if they wish. If there is not enough produced, the accessibility of the farmer's market will provide residents with easy access to healthy locally grown food.

7.6.8.3 Smell

Trees

Plants that provide a fragrance are always a nice surprise when in nature. The light scent can waft into a room and be a reason to go outside and enjoy the scent even closer. The *pua kenikeni* tree's flowers are small tube-like flowers that are white when fresh and change to yellow or orange soon after. They give off a sweet smell and are commonly used in leis. They can be used as both a bush or tree and do well in most areas.³²⁹

Plumeria trees are very popular tree and commonly found around the island. The color and size of the flowers vary. The tree loses its leaves during Winter and reappear in Spring time. The color of the flowers can be white, yellow, pink, or red.³³⁰ *Plumeria* are also frequently used for leis.

Shrubs

The *gardenia* shrub has large white blossoms. They bloom during summertime and have dark green leaves. They only grow six to ten feet tall. The blossoms are very fragrant and are long lasting. There is also the *Tahitian gardenia* which has a "star-like

³²⁹ Ibid. 87.

³³⁰ ILoraine E. Kuck, *The Modern Tropical Garden : Its Design, Plant Materials, and Horticulture*, (Honolulu : Tongg Pub. Co., 1960), 89.

flower has five to nine slender pointed petals arranged like a pinwheel, heavy, waxen, creamy white.”³³¹ This type, however, does not have as strong of a scent.

White ginger is in the family of the pink or plume ginger. However, this plant is seasonal and provides a nice fragrance when blooming. “growing in thick clumps, stalks may arraign seven feet under best conditions with broad, blade-like leaves. Flowers appear in clusters at the ends of the stalks, pushing out as pointed white buds from a smooth, green, waxen bulb made up of scale-like bracts.”³³² The scented flowering trees and shrubs will not only attract insects, but also people outdoors. The fragrant flowers provide an additional element to make people understand seasonal changes.

7.6.8.4 Feel

Trees

While not everyone goes around feeling the texture of plants or trees, an accidental brush up or touch can spark more interest in the plant. The *Hawaiian tree fern* is the most common of the fern trees, “distinguished by a mass of long, soft, golden brown, hairy material, known as “pulu” which covers the top of the trunk. From under this, the new fronds uncurl to a length of three to nine feet, depending on the size of the trunk.”³³³ The texture of both the trunk and leaves make it a great option for providing texture in the garden.

The *royal poinciana tree* is both very visually pleasing and has a variety of texture. “During spring and summer this tree spreads a canopy of flaming red over its branches... Flowers have five petals; in the flag, red variety, one is white, in the orange-red hues, the fifth petal is yellowish... Leaves, doubly compound, with many tiny leaflets...”³³⁴ The shape and smooth texture of the flowers and leaves provide a contrast to the prickly or hairy texture of the Hawaiian tree fern.

³³¹ Ibid. 117.

³³² Ibid. 160.

³³³ Ibid. 93.

³³⁴ Loraine E. Kuck, *The Modern Tropical Garden : Its Design, Plant Materials, and Horticulture*, (Honolulu : Tongg Pub. Co., 1960), 80.

Shrubs

The *monstera* family deliver another option for a variety of texture. It is technically considered a vine and can grow along the ground or vertically. “The leaves are popular as cut material, lasting in water a month or more. The plant has a thick round stem which will grow along the ground, or upright, when its aerial roots find support. The inflorescence is a thick, fleshy, pale pink spathe enwrapping an upright spike. The spike also produces an edible fruit.³³⁵ The very glossy and smooth texture of the fern will entice people to touch.

The *laua’e fern* is another plant that has a very interesting texture. It can be used as a ground covering plant.³³⁶ It has two types of leaves. The glossy smooth leaves and the spore bearing leaves. The shape of the leaves resembles hand-like shape. They are long with finger-like leaves stemming of the center. The glossy texture versus the spore leaves deliver a variety of texture. Typically, when thinking about texture, very coarse or rough materials come to mind. However, a smooth surface is a lack-of texture and provides a necessary contrast to more bumpy surfaces.

7.6.8.5 Sound

Trees

Sound is a great therapeutic element necessary in any healing garden. This can be the gentle rustle of leaves, or the trickling water of a stream. Plants can also reduce urban noise, and provide a more contemplative environment. By creating a wall of trees or shrubs, the noise from cars and trucks can be reduced. *Bamboo* come in many varieties. Depending on its purpose in the garden, there are different sizes. For example, for the courtyard of the community center, the *dwarf bamboo* maybe a good choice for its smaller scale. They typically only grow to 8 feet, with very slender stocks and small leaves.³³⁷ However, the larger species can be used for privacy screening. The larger varieties are much more difficult to control and often spread quickly if not managed. Yet,

³³⁵ Ibid. 181.

³³⁶ Ibid. 194.

³³⁷ Loraine E. Kuck, *The Modern Tropical Garden : Its Design, Plant Materials, and Horticulture*, (Honolulu : Tongg Pub. Co., 1960), 186.

bamboo is a great plant to evoke the sense of sound. As the wind blows through the bamboo, the swaying of the stalks, and the rustle of the leaves create a soothing sound.

Shrubs

Papyrus is a reed like plant that does well in damp soils. The plant consists of “a cluster of long stalks which may attain eight feet. Each end in a busy head of fine grass like greenery. These are really flowering stalks, the flowers being inconspicuous.”³³⁸

Even though there are only two given examples, any tree or plant with flexibility will provide a nice sound when the wind blows. Therefore, the use of all plants will provide sound stimulation.

The selection of tree and shrubs for the master plan should be based on the microclimates of the community site. Each plant requires a unique set of climate conditions to thrive. For example, the mango tree will grow under almost all weather on the island, but they may not flower if there is too much rain. The trees as seen in Figure 33, could be any of the trees listed in this previous section. The selection of trees could be ways in which to entice residents and community members outside. The shrubs and smaller plants could be in the elevated planters or bordering the site. The shrubs and plants would be managed and cared for by the horticultural club. This club would learn how to care for the different types of plants and the necessary climates associated with them. Learning about different plants also provide the opportunity to learn different trades and crafts that utilize the leaves, flowers, vegetables, or fruit. While, Figure 33, only highlighted the elevated planters, the open lawn space around the site could also be opportunities for the community to plant. A key factor for providing a healthy living environment is having control over their environment. By not limiting the gardening to just the planters, residents will have more opportunities to garden, but also control over their environment. By utilizing the open lawn space for growing produce, the site becomes productive and providing food for residents and the café at the community center. The selection of plants can create an atmosphere, so the next step to be completed would be to consult a landscape architect as to how to make the site sustainable.

³³⁸ Ibid. 59.



Figure 79 Master Plan of Community Site



Figure 80 Section Perspective of Neighborhood 1



Figure 81 Section Perspective Through Neighborhood 3



Figure 82 Rendering of Pedestrian Street Walking from Neighborhood 3



Figure 83 Rendering of Neighborhood Two and Pedestrian Street



Figure 84 Rendering of the Community Center from the Pedestrian Street



Figure 85 Rendering from the Community Center 2nd Floor Balcony



Figure 86 Section Perspective of Community Center



Figure 87 Rendering of the Street View of the Community Center



Figure 88 Rendering of Neighborhood Courtyard 2 from the 2nd Floor

8 Concluding Remarks

Through the analysis of the issues that Hawai'i faces such as, the aging population, increasing cost of living, limited housing stock, and the physical and mental conditions developed with aging, it is evident that Hawai'i needs a new type of housing. These issues can make aging in Hawai'i difficult. Therefore, this dissertation is the application of various health and well-being theories to the architectural design of transportable accessory dwelling unit communities.

The first step of this research was to understand how the body and mind ages. It was then necessary to grasp some of the natural therapeutic activities that are commonly employed to delay the onset of physical and mental deterioration. These include physical activity, socialization, and horticultural therapy. Memory and the creation of habits are also imperative to lead a healthy lifestyle. Precedent studies that applied these theories in an architectural manner, were then collected and analyzed. Through the analysis of these precedent studies, the successful features were then incorporated into the proposed design displayed in Chapter 7 of this document.

In Hawai'i, children are taught to respect their elders. Their parents and/or grandparents provided them with many years of guidance and care. Thus, it is important to remember this as they continue to grow older. As young children, many think that their parents will never grow old, and that they will always be the ones to provide for us. Nevertheless, the reality is, everyone grows old, and sooner or later they will need your support. Patience and kindness are necessary to care for our elders because it is a much different experience than caring for a child. A child is still learning and unexperienced. On the other hand, our elders, were once very mobile and independent, and may become frustrated with their lack of independence.

Despite older adults feeling like they are capable of various activities, the development of different physical and mental ailments may make their everyday lives more difficult. If they are lucky enough, they will have a family that helps them with their new found difficulties. However, as the cost of housing, and general living costs increase in Hawai'i, many young families are moving to more affordable cities; leaving their aging parents living alone. This can be difficult on the aging parents, because many are

too proud to ask for help when they need assistance. If they no longer drive, depending on where they live, they may become isolated. If their children are unable to drive them, they can be at risk of developing depression or suffer from other ailments. Since, Hawai'i has many suburban and rural communities, the isolation of elderly is a issue that needs to be addressed.

While, many older adults decide to move into nursing homes or retirement communities, for their daily support and closer proximity to amenities, such moves can often cause anxiety and depression from moving residences. This depression can be crippling mentally and physically. There is a movement to allow elderly to age-in-place. While this is a great option, many elderly deem it too expensive or difficult to make the necessary changes to their homes. This can lead to accidents because of unfit home environments. It can also be very expensive to have a visiting or live-in nurse come to their homes.

For this reason, this dissertation proposes the utilization of transportable accessory dwelling units, to reduce this depression that is associated with moving homes. By remaining in the familiar environment of the accessory dwelling unit, the anxiety and depression that commonly occurs with moving would be reduced. At the new location, the resident would have more opportunities for the therapeutic activities listed in Chapter 4 of this document. Older adults whose children moved away would find a new support system within this community. The design proposal for both the accessory dwelling units and the community site are designed to help prepare for aging.

While, these discussed features will improve the well-being of Hawai'i's aging population, the affordability and feasibility are necessary to address. The small square footage of the proposed accessory dwelling unit, lowers the cost of labor and construction. The smaller the unit, the lower the cost to build and maintain. While this dissertation does not cover cost at a close level, the rough cost estimate for one of the transportable accessory dwelling units is \$125,720. This cost estimate is based on \$280

per square foot from the USA Report of the fourth quarter construction costs of 2016.³³⁹ Construction costs can be further reduced through the mass production of the units or construction elements, such as the four by ten foot wall panels and steel structural frame. The modular construction system will speed up construction time reducing the stress that is commonly found with home renovations and additions. The modular components allow for easy dismantling and reuse. The modules are not only cost efficient, but a sustainable construction system. The unit construction costs do not include the fees for connecting the unit to the water and sewage system.³⁴⁰ Even though buying an accessory dwelling unit seems like a large investment, the financial stress can be reduced by renting the unit or main home. If the ADU is rented out for approximately \$1,500 a month, the unit will be paid off within seven years. The proposed accessory dwelling unit will not only provide extra income, but also help to alleviate some of the strain on the housing market, by increasing the housing stock.

By initially investing in the transportable unit, the occupant has the opportunity to move the unit to the community site at a lower cost. The estimated cost for one-way transportation of the unit, from the single-family home lot in Kahalu'u to the community site in Kaneohe, by Island Movers Inc. is \$1,727.75. This is based on the use of a tractor and low boy vehicle, two police escorts, and operating crane to lift the ADU on and off of the low boy. Once transported to the community site, the occupant would essentially rent the spot in the community center at six month increments. The commercial businesses in the community center, help to manage and maintain the site and facilities. Two days out of the year, the incoming and outgoing accessory dwelling units would be moved in and out using a crane to hoist the units into place.

From the developer standpoint, the business would begin with selling prefabricated accessory dwelling unit. Once most of the accessory dwelling units are sold, then, the design and construction of the community site would commence. The individuals who

³³⁹ Taryn Harbet, *USA Report: Quarterly Construction Cost Report, Second Quarter 2016*, (Rider Levett Bucknall Ltd., 2016), 5-6.

³⁴⁰ "Accessory Dwelling Unit Homeowners' Handbook: A Guide for Homeowners on Oahu Interested in Building an Accessory Dwelling Unit," Hawaii Appleseed: Center for Law and Economic Justice, accessed October 12, 2017, <http://hawaiiadu.org/wp-content/uploads/2016/10/ADU-Manual-ver.-4-FINAL.pdf>, 14.

initially bought the accessory dwelling units would be approached first to reserve a spot within the community site. If they choose not to move the unit to the community site, then new individuals would be approached to buy an accessory dwelling unit and to rent the community space. As a developer it is important to remember that in order for this project to be successful, a significant amount of ADUs need to be sold prior to the construction of the community site. By selling enough units, the income could be directed to the construction of the community site. A great feature of this building model for developers, is that the ADU owners are responsible for the maintenance of their units. The only necessary maintenance needed from the developer is the Community Center, pedestrian pathway, site infrastructure, and the permanent structures. The larger landscape elements such as trees would also need maintenance, but the smaller plants would be maintained by the horticultural therapy club. This plan is still within the conceptual phase. The next steps would be to survey the residents of Oahu on their interest in this housing type.

The proposed community site may receive criticism or opposition because it is unfamiliar to the islands. The construction of the community site is feasible, because it has a similar model that is successful throughout the United States, mobile home parks. Mobile homes provide many low-income families with homes. They are intended for frequent transportation that are parked for a short time within a larger site. While essentially the proposed ADUs are parked within a larger site for an allotted time, they are not intended for frequent transportation, like mobile homes. They most likely will only be moved three times in their lifespans. The proposed community site is not a mobile home park. It is thoroughly planned with community spaces, commercial businesses, and landscaping. The site also has a permanent structure to stack units on top of each other to increase density and minimize building footprint. The main purpose of transportability of the accessory dwelling units, is to promote health aging and allow older adults to take their familiar environment with them. These accessory dwelling units and community site are designed in preparation for aging.

For this document, only one site was selected and designed for the community site. Nevertheless, additional community sites could be implemented throughout the State of

Hawai'i. By providing more sites, a larger variety of communities could be available for Oahu residents. For example, a community site could be designed specifically for elderly who need twenty-four hour care. The design of the site would be very different from the this document's design. Essentially, it might have one large building that units attach to, which would allow the nurses to have quicker access to residents. Another example could be a community site that is located on a more urban site. That community site would have more floors to reduce the building footprint, while maintaining a high density of units within the the site. With any case, the programming of the other community sites may be different, but the core ideas and reasoning are the same.

This housing model will bring relief to the current housing crisis, as well as, provide a new type of community support for the vulnerable elderly. When designing homes or developments, it is important to look at how to apply healthy features at all scales, within the home and on the surrounding site and neighborhood. It is only through the analysis of all scales and the integration of intedisciplinary fields that progress can be made on the issues with current housing. The proposed transportable accessory dwelling unit will help Hawai'i's aging population.

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