THE ANALYSIS OF SHIRAKAWA VILLAGE AND ITS APPLICATION TO MODERN RESIDENTIAL COMMUNITY

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By

Akira Ishikawa

Thesis Committee:

Martin Despang, Chairperson

William Chapman

Socrates Bratakos

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ABSTRACT

In modern architecture, conventional use of prefabricated parts and artificial materials have restricted our scope of creativity and cultural integration; thus, residential buildings have become ordinary and lifeless. Although it is the people whom practice culture, there is a disconnect between various communities. To restore cultural identity and an active residential community, a "sense of village" needs to be embedded into the design.

The Shirakawa Village in Japan is an ideal precedent for this case. Known for its *gassho-zukuri* style housing and its village effort in overcoming obstacles, the Shirakawa Village offers opportunities to investigate how its concept can be applied to the modern residential community to promote health and safety. Furthermore, due to the increasing migration from the village to urban cities by younger generations, the village culture is slowly fading, so this research will also be an effort to preserve village life through the cultural integration process.

By committing to historical research, case studies, and field research, I can identify which elements apply to our modern residential community for more efficient village lifestyle. These explorations will then determine a guideline for programming spaces, which I will use as a basis for my final design proposal. The main objective of this thesis research is to remind future architects the significance of past local villages, and the possibility of becoming a solution for communal issues in modern residential community.

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PREFACE

Since when did Japan start to face a crisis in maintaining Japanese identity in architecture? This may have begun when Matthew Perry and his black ship arrived on present-day Yokohama Bay in the 1850s. Due to exposure to Western influence and domestic rebellion, the last *shogun* abdicated in 1867, which marked the beginning of the Meiji Restoration Era. The newly reformed government was willing to follow Western practices to strengthen Japan's economy and military power to compete in modernity. Shortly after, in 1872 there was a tragic fire incident in the Ginza and Tsukiji district in Tokyo, which destroyed approximately 2,900 structures. The government hired an Irish engineer Thomas Waters to construct a new urban plan for these districts. Since the cause of rapid fire spread was overcrowded wooden buildings, the new urban proposal consisted of building brick structures in a grid layout.

In 1871, College of Engineering was established in Tokyo Imperial University to generalize the Western practices of civil engineering, metallurgy, mining, and telegraphy. As Japanese architects began to familiarize themselves with this knowledge, they slowly realized the presence of Japanese culture weakening within the field of architecture. In response to the declination, several architects have experimented how to maintain Japanese identity while using Western practices, including Chuta Ito, Jin Watanabe, and Kunio Maekawa.[1]

[1] Reynolds, Jonathan M, "Can Architecture Be Both Modern and 'Japanese'?: The Expression of Japanese Cultural Identity Through Architectural Practice From 1850 to the Present," in *Since Meiji: Perspectives on the Visual Arts, 1868-2000* (Honolulu: University of Hawaii Press, 2012), 315-327.

Chuta Ito is a graduate of Tokyo Imperial University, College of Engineering. One of his famous works is the Great Kanto Earthquake Memorial in 1923 (Fig. 1). The temple built prior was burnt down during the earthquake, so Ito decided to use concrete as the main building material. The overall form is still a temple; however, some architectural elements served no structural purpose and were considered ornaments. For example, concrete rafters were deemed redundant because the concrete roof alone was structurally stable. Is this the type of cultural integration that we hope to practice? Similarly, another Tokyo Imperial University graduate Jin Watanabe redesigned the Tokyo Imperial Household Museum in 1931 (Fig. 2). To maintain Japanese identity, Watanabe proposed a tiled roof with a triangular gable on top of concrete mass.[2] One may argue if placing a traditional Japanese roof will make the entire building "Japanese." From these precedents, you can assume that the initial attempt of cultural integration was heavily form- and material-conscious.

[2] Reynolds, "*Can Architecture Be Both Modern and 'Japanese'?*," 319-324.

Figure 1. Chuta Ito, Great Kanto Earthquake Memorial Hall. Exterior. 1930, Tokyo. Source: Reynolds, "Can Architecture Be Both Modern and 'Japanese'?"

Figure 2. Jin Watanabe, Tokyo Imperial Household Museum. Exterior Sketch. 1931. Source: Reynolds, "Can Architecture Be Both Modern and 'Japanese'?"

Kunio Maekawa is another Tokyo Imperial University graduate, who worked in Le Corbusier's studio for two years. He had a strong passion for modernism and had a different approach to Japanese cultural integration. During the 1950s, he designed the Harumi Apartments, a 168-unit residential building with the skip-floor system (Fig. 3). Although it was built using concrete and steel, the rooms were laid out with tatami mats to suggest flexibility in functions.[3] The Japanese use tatami mats for multiple occasions such as eating, sleeping, and socializing. This spatial reference is closer to my understanding of cultural integration in modern buildings, which is more focused on implementing Japanese values into space and function for users. If the situation or site allows bringing back the traditional form or local materials, then it should be implemented as an addition but not a necessity.

[3] Reynolds, "*Can Architecture Be Both Modern and 'Japanese'?*," 326-327.

Figure 3. Kunio Maekawa, Harumi Apartments, Interior. The 1950s, Tokyo. Source: Reynolds, "Can Architecture Be Both Modern and 'Japanese'?"

I believe researching an entire village in addition to individual houses will provide me with a better understanding of Japanese culture. The "sense of village" can be implemented into residential buildings in modern urban context to promote active community lifestyle and maintain cultural identity. It is notable that Japan is currently known for its declining population and rising elderly population. While the middle-aged population is preoccupied with their occupations, elderly care is constantly in high demand. On a different note, students are always in need of dormitories, which is why there are many shared housing projects. If the elderly and student communities unite as a cohesive system, perhaps there is an opportunity to resolve issues from both age groups. My final design proposal will be a residential complex for both elderly and students which will overcome common obstacles through active engagements.

This research will lead you through research phase and design procedure of culturally integrating a “sense of village.”

CHAPTER 1: INTRODUCTION

1.1 My Experience

During the winter of 2017, I invited my classmates to a journey to the Shirakawa Village in the border between Toyama and Gifu Prefectures. As we rode on a tour bus from Nagoya, there was nothing but dense vegetation and steep topography. What I find interesting is the series of mountain tunnels we had to go through to get to the destination. Each time we pass through a mountain, the scenery becomes more serene with an abundance of nature. The final transition was a panorama of the clear river in the valley and mountains covered with patches of thin snow. Even though we were on a bus, the tranquility of the scenery draws forth the sound of the river flowing in my head. I knew at this moment that we have finally entered an isolated region.

Unfortunately, this feeling instantly vanished as we arrived at the Shirakawa Village. The supposedly isolated village is now invaded by heavy traffic of tourists and presence of automobiles. It doesn't help that we arrived riding on a large express bus. The status of World Heritage Site has attracted too many tourists and modern buildings in response to incoming foreigners. Some of these vernacular houses were renovated to accommodate guests staying overnight. Also, there are instances where the house becomes a gift shop, which I think is a waste of opportunity. We decided to pass through the entrance of the village hastily and explored the unique architectural style instead. The *gassho-zukuri* houses are known for their dominant A-frame roof covered in

thick thatching to resist heavy loads of snow during winter. One beautiful aspect is the moss growing on the surface of the thatched roof. It was an alternative way to experience time itself, as I imagine the thatched roof going through a repetition of seasonal changes. I usually consider roof as a building element that prevents outside elements from harming the users or the building itself. However, the moss suggests “acceptance” instead, adding to the aesthetic feature of the vernacular house. I realized later that moss usually grows on a north side of a tree, so does the similar concept apply to the roof? If so, it would be interesting to perceive moss as a symbol for directionality. During winter, I heard that two to three feet of snow is accumulated on the roof – yet another form of “acceptance.”

As I look closely at the craftsmanship of thatched roof, I can visualize the community performing tedious work. The consistency of reeds makes it seem as if the roofing is a single entity. This is distinctly different from the repetition of ceramic tiles used on other traditional buildings. Tiled roof has a definite outline of individual tiles, creating a systematic pattern. However, reeds in the thatched roof are smaller scale in width so instead of a distinct pattern, the entire collection of reeds are perceived as one building element.

The opposite end of the village had more preserved landscape and buildings. This was where I had a breathtaking experience of scenery alone (Fig. 4). The angle of the perspective was perfect to create an illusion that the thatched roof is part of nature. To augment the effect, the moss on the roof matches the color of nearby grass patches. Its natural transition made me

realize that perhaps the houses were not meant to be observed from the same elevation. Since the village is surrounded by mountains, it is most likely that you will arrive at the site from a higher elevation. I think the first impression of the site has a subtle impact, but immediately following up with a stronger impact. What I mean by this is that people will first perceive these triangular houses as part of the landscape due to the natural materiality of the thatched roof. However, as observers slowly approach and begin to realize that these miniature hills are buildings, that is when they are in the notion that they encountered a village. I think the perception in winter is opposite of this. The roof may have accumulated snow, but this instead accentuates the triangular facade perpendicular to the ridge. The essence of these houses is revealed in winter, perhaps to prevent travelers from getting lost in the heavy snow. As Bruno Taut have once said, “This landscape is not like (any) other Japanese style. At least I have never seen it before.”[4]

[4] “World Heritage Site, Historic Village of Shirakawa-go,” *Hida Takayama Tourist Information*, 2018, accessed April 2, 2018, http://www.hida.jp/english/touristattractions/4001419/4000089.html.

Figure 4. Gassho-zukuri Houses, View from Different Angle. 2016, Gifu. Source: Author.

1.2 Site Conditions

The Shirakawa Village, also known as Ogimachi, is settled in Gifu Prefecture which is part of the central region in Japan mainland. Settled above 500 meters from sea level, this village is surrounded by vast mountainous range shrouded with forests (Fig. 5). Two other villages still exist called Ainokura and Suganuma in Gokayama region, but due to limited information and access, this research will focus primarily on Ogimachi. Geographic statistics show that 96% of the village area is a forested region, while only 0.4% is for agricultural purposes.

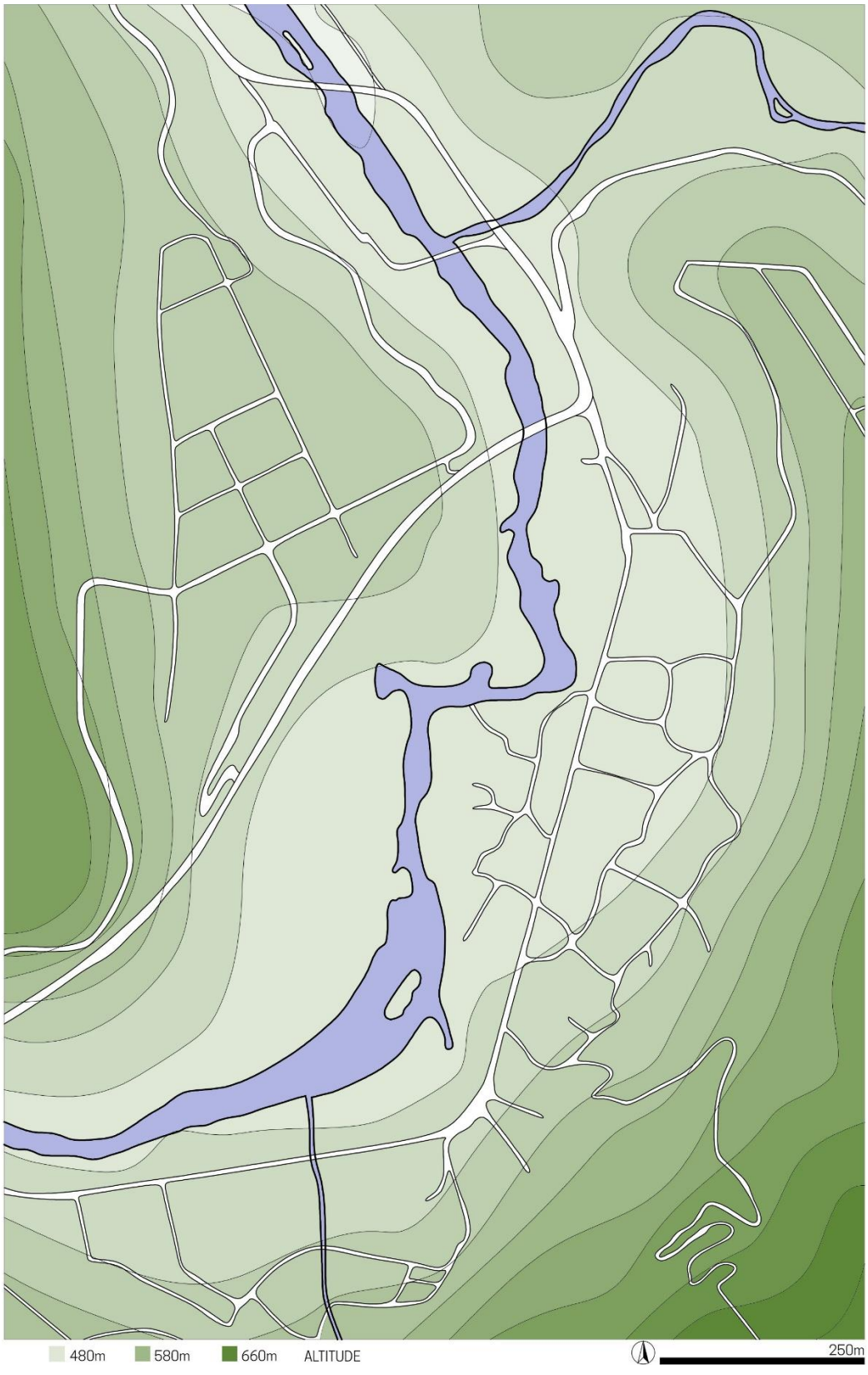

Figure 5. Topography Diagram of Ogimachi, Shirakawa. Source: Author.

There is an extreme difference in temperature between summer and winter that requires strenuous maintenance from the residents (Tab. 1). In winter between December and March, it is reported that snow can accumulate up to 2 to 3 meters or roughly 6 ½ to 10 feet. The highest snowfall was 4.5 meters, which is the reason why the village is considered to be one of the most isolated and unapproachable in Japan.

Table 1. Average Monthly Temperature in Shirakawa, 2015. Source: http://ml.shirakawa-go.org/en/wkp/

The village itself stretches out in north-south axis along the Sho River. The arrangement of the *gassho-zukuri* houses mimics the course of the river. Originally, these houses were built far apart from each other to prevent the spread of fire incidents. However, modern houses are now built between these pre-existing structures, so it is difficult to recognize the village's attempt of compartmentation.[5]

There are three main reasons why its roof orientation generally runs along an east-west axis. Firstly, constant sun exposure is essential to the durability of roof thatching. The east-west roof surfaces can receive maximum sunlight available in a narrow valley. Second, fierce winds are frequently blowing along a

[5] *UNESCO World Heritage Shirakawa-Go: Traditional Houses in the Gassho Style* (Ogun, Gifu Prefecture: Shirakawa-go Tourist Association, 2013), 15-16.

north-south axis, which means the roof surfaces are not exposed to direct wind force. Lastly, every house has a Buddhist altar positioned on either north or south wall of a house. In case of fire, the back wall can be easily removed from outside for easy transport. In addition, each orientation of the houses was well organized to prevent the Buddhist altar from facing a lavatory of a neighboring house.

Broad-leaved trees populate the forested region, and cedar trees flourish at the base of the mountain. These areas have soil property of Shirakawa granite and Nohi rhyolite. In the settlement area, the aquifer layer is alongside the surface, creating a wetland terrain that requires attention in building a foundation.[6] On the other hand, this brings opportunity to grow rice fields as one of their food source. However, due to the surrounding topography, the community could not create as much rice fields as they had desired because the site receives considerably less sunlight. To compensate for this disadvantage, the villagers instead grew millets which were easier to maintain and harvest abundantly. These were normally produced far from the village, along the base of the mountain on sloped ground. Also, villagers avoided bush-grown fruits and vegetables; so when heavy snow starts to accumulate, inhabitants can shovel the snow without concern. Therefore, some other food sources include

[6] Hisano Toyoshima and Hidetoshi Saito, "水環境への適応とその持続的活用形態からみた山村集落の文化的景観評価 [Evaluation of Cultural Landscapes from the Water Environmental Aspects]," in 日本建築学会計画系論文集 [Architectural Institute of Japan: Journal of Architecture, Planning, and Environmental Engineering] Vol. 74, No. 642 (2009), 1905-1910.

persimmon and pear trees, and root vegetables such as potatoes and Chinese cabbages.[7]

Adjacent to the Sho River, there are water networks that course through the village. These small networks were used for agricultural and cooking purposes. Near a *gassho-zukuri* house, there is a larger pool of water beside the eaves of a roof (Fig. 6). Residents use this as means to melt the snow faster by climbing up the roof and shoveling snow into the pool of water.[8]

Figure 6. Gassho-zukuri House, Water Network. 2016, Gifu. Source: Author.

Since Sho River was at a lower elevation than the village, it was difficult to retrieve water using the networks. In addition to this disadvantage, the river was said to be unapproachable due to the rapid flow of water. The village community

[7] Shuko Mizunoe and Noriaki Nishiyama, "明治中期の土地利用にみる合掌造り集落の空間構成と伝統的景観 [Traditional Landscape and Specification of Rural Village by Historical Land Use]," in 日本建築学会計画系論文集 [Architectural Institute of Japan: Journal of Architecture, Planning, and Environmental Engineering] No. 622 (2007), 91-96.

[8] 四百年生きる家～白川郷：合掌造りの秘密～[House That Lasted 400 Years: Shirakawago, The Secret of Gassho-zukuri]. Shirakawa, Gifu: TV Asahi, 2005. Video Tape.

had to search for other sources of water to achieve a self-sustainable agrarian lifestyle. Within Ogimachi, there are currently roughly 21 active spring water points. These spring locations were called *shuuzu*, which is an exclusive vocabulary used only by these residents. Most of the *shuuzu* are seen along a rock wall next to the streets and draws spring water from two primary spring sources underground (Fig. 7). Another method of retrieving water is through wells. A recent study shows there are more *gassho-zukuri* houses built near *shuuzu*, but apparently less in areas where wells are dug. It may suggest hierarchy within the village as dwellings adjacent to *shuuzu* had a prospering business while others may have had financial challenges. This conjecture is further supported by observing the buildings built next to two major sources of spring water. Significant structures of the Wada Residence and Myozenji Temple occupied these water sources. Nevertheless, this water system was able to sustain a considerable number of households, which at one point reached a total of 88 houses in 1872.[9]

[9] Hisano Toyoshima and Hidetoshi Saito, "水環境への適応とその持続的活用形態からみた山村集落の文化的景観評価 [*Evaluation of Cultural Landscapes from the Water Environmental Aspects*]," 1906-1909.

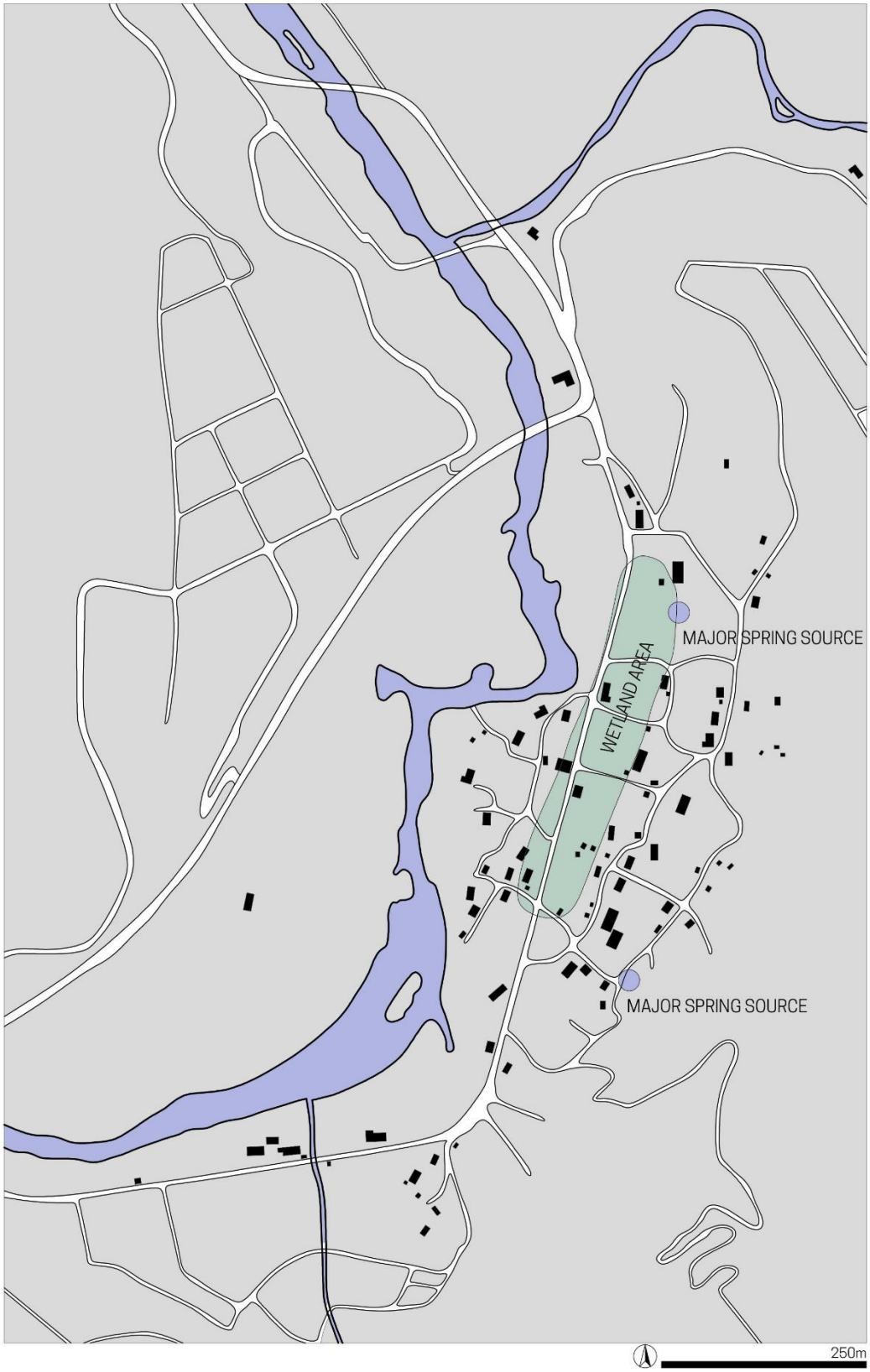

Figure 7. Water Source Diagram of Ogimachi, Shirakawa. Source: Author.

1.3 World Heritage Site

Due to the lack of archeological artifacts, it is difficult to hypothesize the daily lifestyle in Shirakawa Village before the 12th century. However, excavated earthenware pots and stone tools reveal that the earliest settlement possibly dated back to the late Jōmon Period (8000 B.C. – 200 B.C.).

Before the 1600s, there were approximately 50 houses in Ogimachi. By mid-Meiji era (1868-1912), the number has increased to over 100 houses in the area. This enlargement of the village was partly because of the development of sericulture. Silk became the main commodity, which supported the economy of the village. As business prospered, small footpaths within the community later broadened into narrow roads for transporting heavy loads. In 1890, the government completed a national highway that coursed through the village, exposing modern building methods to the community. As a result, many people were influenced and built modern tin-roofed houses along the major road. More modernization occurred after the World War II when Japan experienced high economic growth, leading to series of dam construction near the village. Also, the economic growth and establishment of old national highway allowed more people to afford domestic tourism.[10]

As people began to build modern houses due to the strenuous maintenance of *gassho-zukuri* style houses, the village authorities started a preservation movement in 1967. Four years later, Shirakawa-go Ogimachi Natural Environment Preservation Society was established by residents, creating

[10] *UNESCO World Heritage Shirakawa-Go: Traditional Houses in the Gassho Style*, 15-16.

guidelines of how to preserve the historic structures. In 1995, UNESCO, or United Nations Education, Science, and Culture Organization declared Ogimachi as one of the World Heritage Sites. According to the 2013 research data, there are currently 114 *gassho-zukuri* style buildings in the village along with 329 non-*gassho zukuri* style buildings.[11]

[11] *UNESCO World Heritage Shirakawa-Go: Traditional Houses in the Gassho Style*, 15-16.

CHAPTER 2: GASSHO-ZUKURI STYLE HOUSING

2.1 Origins of *Gassho-zukuri*

It is believed that *gassho-zukuri* style houses were developed from *koya*, or small primitive tent-like structures (Fig.8). Researcher Yuuko Shimpuku made observation notes that in 1889 one-fourth of the structures in the village were *koya*, suggesting these typologies were the initial stage in the development of *gassho-zukuri*. The general structure of *koya* relies on rafter-like wooden members, forming a triangular cross section. Unlike conventional cubic room, the triangular room had uninhabitable space along the corners, so they were used as storage space instead. For sleeping, dwellers hung hammocks from its leaning roof for better comfort. There are four fundamental spaces within *koya*: *niwa, oe, omae,* and *heya*. Starting from the entrance, *niwa*, also known as *doma*, is usually a cooking space with compacted earth as flooring. The central *oe* is a family living room with a sunken hearth to prevent fire from spreading to nearby flammable materials. Lastly, *omae* is crucial reception room for Buddhist altar and *heya* is a bedroom for residents. It suggests that Buddhism religion was a principal factor in their lifestyle because it was brought back to *gassho-zukuri* style housing.

As Japan entered new eras, the village was exposed to different sociological and economic conditions. The building layout was heavily influenced

by these factors and transformed to work-live housings for the village community.[12]

Figure 8. General Sketch of koya, Dimensions, and Layout. Source: Yuuko Shimpuku, "The House 'Gassho-zukuri' in Toyama Prefecture (Part 1) Historical Study."

Between 1585 and 1871, the Gokayama area was governed by the Kaga Domain, which is the current Kanazawa Prefecture located north of the village. Instead of paying tax to Kaga Domain with rice, they were required to pay by monetary coin system. For the self-sustainable village to earn a profit, they relied on paper production, sericulture, and gunpowder production as main

[12] Yuuko Shimpuku, "富山県の合掌住宅(第1 報)その史的考察 [The House 'Gassho-zukuri' in Toyama Prefecture (Part 1) Historical Study]," in 家政学雑誌 [Journal of Home Economics of Japan] Vol. 26, No. 3 (Tokyo: The Japan Society of Home Economics, 1975), 217-218.

commodities. These work operations demanded sizeable open space, which may explain why *koya* was not an appropriate labor environment.

Sericulture practice and paper manufacture can be identified earlier in the 1530s, and gunpowder production dates to 1605. Families that inherit these practices had built *gassho-zukuri* style houses for better work environment. On the other hand, the remaining people living in *koya* would walk over to these houses to help with the production. Business families would then reward workers with basic necessities such as food rather than coins. Other jobs for *koya* residents include mountain jobs such as wood and food gathering. Not only did the difference in house structure establish work diversity, but also a social hierarchy. It is assumed that people living in *koya* were inferior, whereas the *gassho-zukuri* residents were successful in business.[13]

2.2 General Layout

The *gassho-zukuri* style housing may have evolved from the *koya* structures; however, there have been several types of expansions by owners afterward that characterized the floor plan of each house. Fortunately, these houses still have a consistent pattern of core functions inherited from the *koya*.

In the present Shirakawa village, there are several display houses throughout that shows visitors the interior of a typical *gassho-zukuri* style housing. The Kanda Residence is one of these exhibitions (Fig. 9). The Kanda

[13] Yuuko Shimpuku, "富山県の合掌住宅(第2 報)その生産的役割 [The House 'Gassho-zukuri' in Toyama Prefecture (Part 2) Its Role as a Productive Place]," in 家政学雑誌 [Journal of Home Economics of Japan] Vol. 26, No. 4 (Tokyo: The Japan Society of Home Economics, 1975), 303-304.

family was first established by Yaemon Wada when he changed his family name to succeed Kichiemon Kanda of Ubusuna Hachimangu Shrine. The house is said to have been built by the shrine carpenters from Ishikawa prefecture within a span of ten years. The construction occurred in the latter half of the Edo period, referring to traditional typologies of *gassho-zukuri* style.[14] What seemed interesting is the juxtaposition of Shintoism and Buddhism in this context. Although there is a shrine in the village, there are Buddhism altars in each of the house. Of course, this means that there are more Shinto and Buddhism followers than total village population, suggesting that some people practice two religions.

Figure 9. Kanda Residence, Exterior View. 2016, Gifu. Source: Author.

[14] *World Cultural Heritage Hida Shirakawago: Kanda House* (Ogun, Gifu: Shirakawa-go Tourist Association).

The spatial layout of Kanda Residence is relatively similar to the origins of *koya* structures (Fig. 10). Although the entire structure is extremely larger than its predecessor, some expansion spaces can be disregarded to focus on the core functions. One distinct difference is the location of the entrance. Unlike the entry of *koya* located on the triangular facade, the Kanda Residence has its entrance along the side of the structure. Another interesting point is that the function of *niwa* has been separated into entrance and kitchen space. However, both entrance and kitchen space were still at ground level while the rest of the areas were elevated with refined flooring such as tatami mats. The bedrooms and Buddhism altar are again organized farthest from the entrance. Since *gassho-zukuri* style housing can accommodate more functions, *tokonoma*, *souryou no heya*, and *de'e* were added to the collection. From the sequence of space, one can assume that social hierarchy is implemented in programming. As the rooms become more distant from the entrance, they are more private or reserved for revered individuals.[15]

[15] *World Cultural Heritage Hida Shirakawago: Kanda House* (Ogun, Gifu: Shirakawa-go Tourist Association).

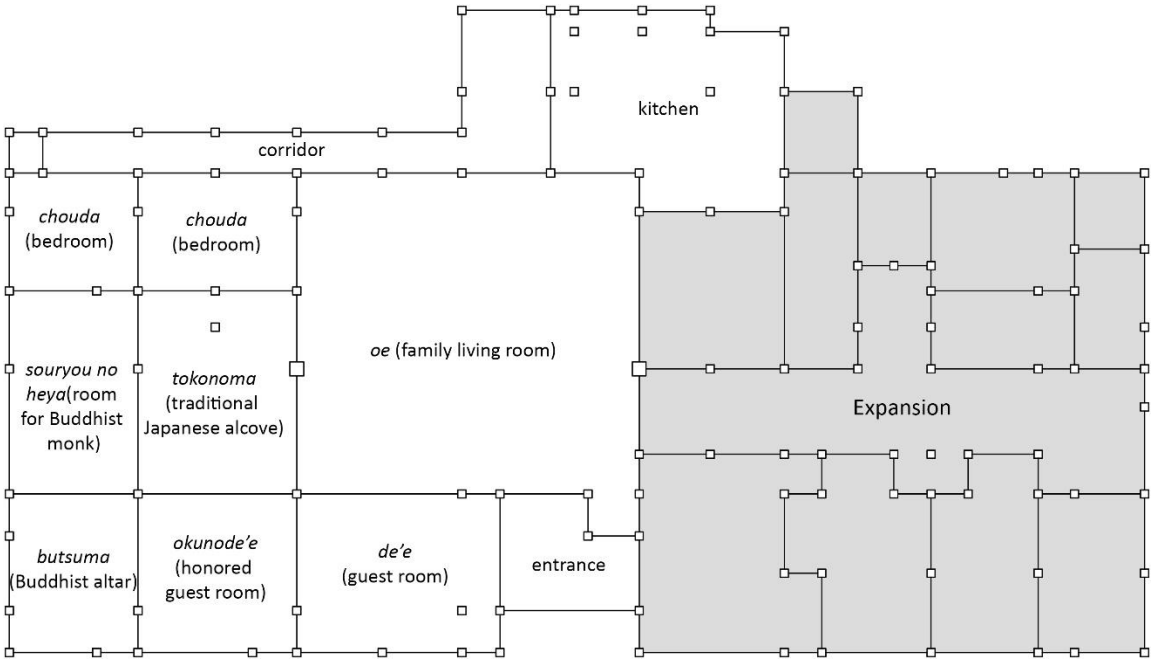

Figure 10. Spatial Layout of Kanda Residence, First Floor. Source: Author.

The significant difference between these two typologies is the number of floors within a single house. The *koya* structures have a single floor, but the *gassho-zukuri* style structures generally have 3 or 4 stories. As the core functions of *koya* were effortlessly transferred to the first floor of *gassho-zukuri* style housing, the upper levels were solely used for a workstation to practice sericulture. Similar to *koya*, the attic space of *gassho-zukuri* style house was uninhabitable due to lack of height. Nonetheless, the Kanda residents brilliantly utilized that space as breeding room for silkworms, just as *koya* residents used their corner spaces as storage. Also, it is important to note that the silkworms were farthest away from the central hearth on the first floor to avoid excessive heat exposure.

2.3 Structural Features

The overall structure of *gassho-zukuri* style house can be divided into two sections: the *koyagumi* and the *jikugumi*. As the name suggests, *koyagumi* is the upper half of *gassho-zukuri* style house that has a dominant triangular figure, which resembles the form of its predecessor (Fig. 11). Another notable point is that the roof resembles the gesture of praying hands, hence the Japanese translation "*gassho*" was used to describe the style (Fig. 12). In normal circumstances, there are usually columns supporting the ridgepole; however, the weight of its roof is heavy enough to keep the entire roof stable without needing vertical support.[16] With the absence of columns, the users have more freedom and circulation, especially the upper floors as space gets smaller. On the other hand, the *jikugumi* or first floor of the *gassho-zukuri* structure generally has set of columns as shown in the previous spatial layout of the Kanda Residence.

[16] "Gassho-Style Architecture," *Kamitaira Vill*., 2004, http://www.gokayama.jp/english/heritege/stylearchitecture.html

Figure 11. Typical Koya Typology. 2016, Gifu. Source: Author.

Figure 12. Typical Gassho-zukuri Typology. 2016, Gifu. Source: Author.

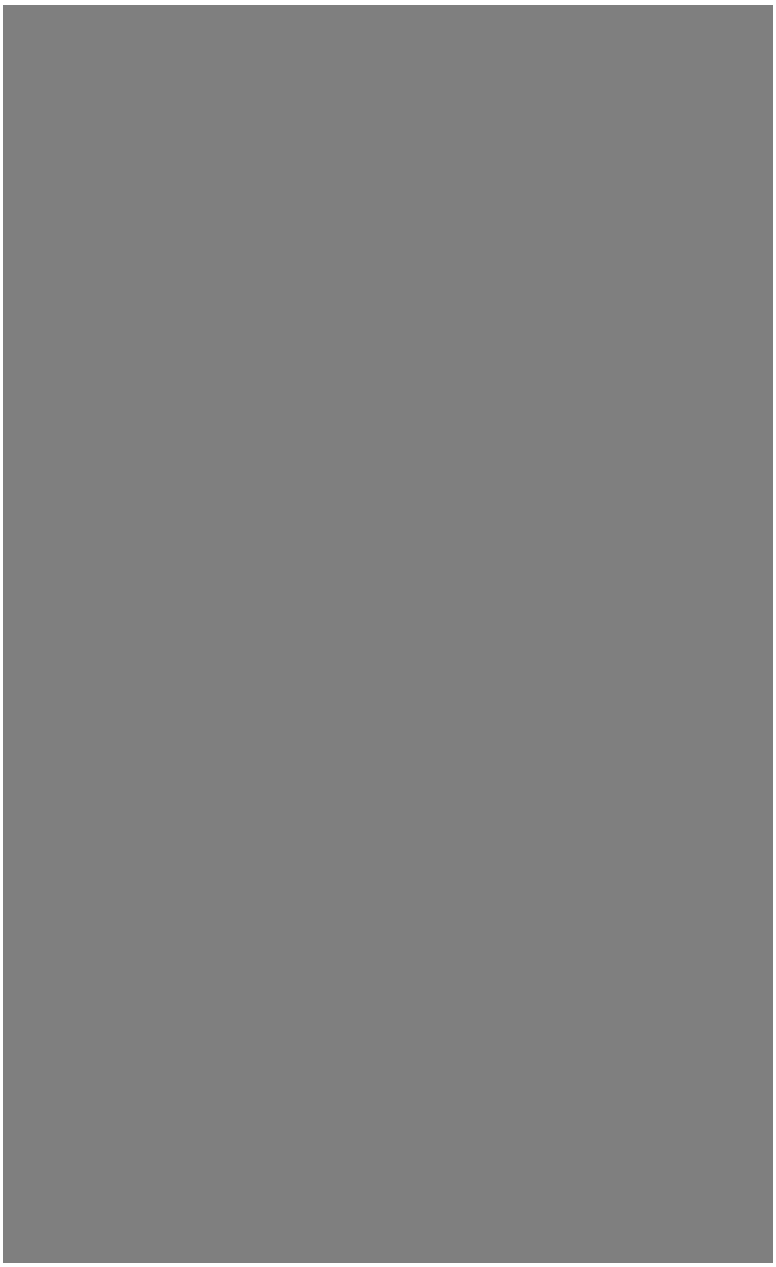

Figure 13. Construction Procedure of Gassho-zukuri. Source: http://bunka.nii.ac.jp/suisensyo/shirakawago/MAINTEXT/outline-fig2-1-j.html.

The two distinct components of *gassho-zukuri* style house raise the question of how they are structurally connected. On the second floor, there are *komajiri*, or pin-joints, used for connection to disperse the incoming forces in situations of high winds or earthquake. One could assume the *jikugumi* itself is a

vertical extension of a solid foundation, whereas *koyagumi* is the counterpart of it that allows structural flexibility (Fig. 13).

Another interesting feature is that the house is built on stilts. The foundation consists of cornerstones placed underneath each wooden column. This is to prevent faster deterioration from moisture and termite damage. For sturdiness, the stones are carved according to the outline of column bases. Massive wooden beams are then placed on top of these cornerstones to begin laying out the framework. There are also wooden structural beams called *chonabari*, which are bent beams that support the densly thatched roof. The villagers would search in the nearby forest for naturally curved trees that withstood yearly snow loads. These are selectively chosen because they are already prestressed, similar to the makings of precast concrete slab.

There are three stages of construction: foundation, framework and other wooden architectural elements, and thatching. For foundation, cornerstones are buried firmly by hammering them with large wooden beams as villagers repeatedly lift up and down. Then *daiku* and *kobiki no shokunin*, Japanese carpenter and sawyer respectively, arrive at the construction site to commence the second stage. The professionals would measure and cut timber for structures, walls, and flooring. Due to isolation from developing cities, the Shirakawa village relied on surrounding resources from nature. Structural members are connected using straw ropes (Fig. 14).[17] This could also be another factor in dispersing forces from outside source. Japanese nails called

[17] Ahmad Yani, "Local Wisdom of Traditional House in Earthquake Risk Mitigation," *Atlantis Press* (2016): 17-21.

wakugi, and Western nails called *yokugi* were only used on wall and floor planks. Taking full advantage of local materials show superb adaptation as well as respect for nature.

Figure 14. Straw Rope Assembly, Attic Space. 2016, Gifu. Source: Author.

2.4 Thermal Efficiency

According to one field survey, the central hearth on the first floor of the *gassho-zukuri* house is sufficient to provide thermal comfort for every floor (Tab. 2). Each flooring has porous property allowing ventilation as well as thermal

radiation. The porous flooring is made from sticks tied to each other by straw ropes and is laid out alongside solid central flooring. Vertical thermal radiation is efficient in this typology because as heat rises, the volume of space shrinks, maintaining thermal comfort for residents.

Table 2. Thermal Analysis of Typical Gassho-zukuri Style House. Source: Tajima, "Measurement of Thermal Environment in Winter in Gassho-Style House."

Researcher Keiichi Tajima and his associates placed thermal heat detectors and thermometers on each floor as well as outside for control variable.[18] Although the first floor has higher thermal radiance than attic space,

[18] Keiichi Tajima, Tomoyuki Chikamoto, and Tomohiro Kobayashi, "Measurement of Thermal Environment in Winter in Gassho-Style House," *Architectural Institute of Japan* (2012): 435-436.

the overall air temperature is stable. This is slightly different from the conventional method of installing HVAC system into a house. As Lisa Heschong have once said, “when thermal comfort is a constant condition, constant in both time and space, it becomes so abstract that it loses its potential to focus attention.”[19] When relying on air conditioning system, the microclimate becomes stagnant with consistent temperature, preventing users from appreciating thermal sensation. However, if the source of heat is fluctuating regarding thermal radiance, then users will be more conscious of their thermal environment. To prevent this unpredictable fire from spreading to unwanted areas, the users require surveillance. In the Kanda residence, there is a fire watch window installed on the second floor (Fig. 15). It is a small sliding window that enables users to leave the central hearth while monitoring fire condition from above.

Figure 15. Fire Watch Window, Kanda Residence. 2016, Gifu. Source: World Cultural Heritage Hida Shirakawago: Kanda House.

[19] Lisa Heschong, *Thermal Delight in Architecture* (Cambridge, Massachusetts: MIT Press, 1979), 36.

CHAPTER 3: SENSE OF VILLAGE

3.1 Sustainability

Like many other vernacular villages, the Shirakawa village had to self-sustain with local resources. One amazing aspect that needs to be pointed out is their innovative methods in utilizing what seemed a negative element into a favorable condition.

One good example of sustainability is the central hearth in the *gassho-zukuri* style house. Fire is a primitive language of gathering, granting residents safety and warmth as well as opportunity to cook. As they socialize around the hearth, smoke continues to arise and filters through porous flooring on upper floors. The smoke then makes contact with exposed wooden beams and leaves a thin layer of soot. A typical reaction would be to clean smudges; however, the residents purposely allow the soot to accumulate slowly. This conveniently becomes a natural insect repellant against termites and improves the structural durability of wooden members.[20]

To fuel the fireplace, villagers can simply walk out and cut down trees. Due to the mountainous terrain, sloped hills were advantageous in transporting large loads of wood. Even in winter when there is heavy snowfall, villagers would use a sled to transport wood without wasting energy in unfavorable environment. In addition, during the Edo Period, the shogunate demanded abundant resources of trees from the Shirakawa region. Although this is an isolated village, wood

[20] Ahmad Yani, "Local Wisdom of Traditional House in Earthquake Risk Mitigation," *Atlantis Press* (2016): 17-21.

was transported to neighboring Takayama City via Sho River, taking advantage of north-south current and buoyancy from trees. The wood is then transported by ship to other cities.

Another sustainability concept found in the lives of *gassho-zukuri* residents is the recycling of outputs in each process of thatching, sericulture, and paper production (Fig. 16). For thatching, Miscanthus reeds were harvested and dried before making bundles for roofing. When the outer layer of thatched roof is replaced by the new, the deteriorated reeds were mixed into soil as fertilizer to grow mulberry trees. For paper production, villagers would use these mulberry trees as the main material. Not only were tree barks pulped for fibers, but also its leaves recycled as food for silkworms. While the pulp is dried under direct sun, the villagers would collect silk from well-fed silkworms. It is probable that the idea of paper production and sericulture becoming their main commodities was not suggested by the government, but rather from collective thinking within the village of how to efficiently use limited resources.

Figure 16. Sustainable Process of Thatching, Paper Production, and Sericulture. Source: Author.

3.2 Concept of *Yui*

The Shirakawa village only had themselves to overcome obstacles, which was how the labor sharing system called *yui,* or bonding, was established. The individuals would cooperate on arduous tasks such as hammering the foundation stones with a large wooden beam, as previously mentioned. These type of approach is similar to typical Japanese social characteristic of being dependent on one another.

The *gassho-zukuri* style houses are not only known for its massively thatched roof but also the communal effort involved in this practice (Fig. 17). Thatching usually takes place in autumn or spring when the climatic condition is not extreme. Villagers would use a type of Miscanthus reed called *kogaya*, which thrives in sloped topography. Since the terrain is mountainous, they can be grown anywhere nearby.

Figure 17. Communal Effort in Thatching Roof, Gifu. Source: UNESCO World Heritage Shirakawa-go: Traditional Houses in the Gassho Style.

For a better idea of material consumption, researchers Naoko Wada, Masakazu Suzuki, and Makoto Yokohari investigated how much Miscanthus reeds are necessary for thatching. The research took place in Ainokura village, but these results could be applied to typical *gassho-zukuri* households in any village. From interviews and aerial survey, they made a general assumption that it takes 20 bundles of *kogaya* for every square meter of ridgepole, and 22 bundles for roofing, which totals to approximately 5,324 bundles per house. In 1968, Ainokura village had 88,000 m^2 of *kogaya* grown nearby for thatching. One can imagine the necessary teamwork to harvest, dry, bundle, transport, and assemble *kogaya* for thatching process. Their efficiency in refined teamwork has enabled them to finish rethatching of a single house within one day. This process should be done as swiftly as possible in consideration to possible rain during the operation. Layering wet bundles of *kogaya* on top of one another will catalyze natural deterioration, which then demands another rethatching next year.[21]

Unfortunately, the current issue of *yui* lies in its preconceived notion that it refers to rethatching of the roof. When individuals think of Shirakawa Village, they are first reminded of the thatched roof, instead of the collaborative effort of *yui*. The origin and history of *yui* need to be clarified to understand that the labor-sharing system was not established solely for rethatching of roofs. The original definition of *yui* can either mean the gathering of branch families and outsiders by

[21] Naoko Wada, Masakazu Suzuki, and Makoto Yokohari, "五箇山相倉集落における茅葺き屋根維持システムに関する研究 [*A Study on the Maintenance System of Thatched Roofs in Gokayama Ainokura Village, Japan*]," in *Landscape Research Japan*, 689-694.

large farm owner, or family effort to do small-scale agricultural tasks. Of course, this idea can also be identified in other regions of Japan, such as *yuimawaru* in Okinawa. This similarity suggests that the term *yui* was used throughout the country in different situations. As time changes, the perception of *yui* transitions from individual agricultural tasks to public rethatching work. Furthermore, rethatching is performed in certain seasons, so the application of *yui* becomes more limited. Unlike the absolute necessity to do agricultural job for profit, it has become a voluntary gathering.[22] It is essential to perceive *yui* as a communal effort in multiple scenarios; otherwise, the significance of it will slowly decline along with the practice of rethatching.

Therefore, other examples of *yui* should be appreciated like the maintenance of water network system. As previously mentioned, *shuuzu* is a spring water point where residents retrieve water for either agricultural or cooking purposes. At the same time, it can be a meeting place between households for greeting and exchange of information. To maintain the beauty of these water networks, the village conducts a biyearly maintenance called *yusuisarai* by the residents.[23] The community would gather to clean these water networks to maintain clean water since it is a valuable resource in this region. The *yusuisarai* should not be perceived as an obligation for cleaning, but opportunity to lead the community to social solidarity.

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[22] Mika Uchiumi and Nobu Kuroda, "白川村の「結い」と「屋根葺き替え」の変遷に関する研究 [A Study on the Change of 'Yui' and 'Rethatching' of Shirakawa-mura]," in Landscape Research Japan Vol. 72, No. 5 (2009), 665-667.

[23] Hisano Toyoshima and Hidetoshi Saito, "水環境への適応とその持続的活用形態からみた山村集落の文化的景観評価 [*Evaluation of Cultural Landscapes from the Water Environmental Aspects*]," 1906-1909.

3.3 Organizations

Since Shirakawa village is in an isolated region, the community must develop countermeasures from natural disaster as well as foreign intrusion. When villagers were asked what their major concern was, they replied fire disaster from flammable roofing. In 1912, there was a great fire incident that burned down one temple and 57 houses, which was 70% of the houses in the area.[24] In addition, the development of highway has allowed tourists to visit Shirakawa village, which may have raised some concerns among the residents. Two associations within the village respond to these key concerns.

To discuss matters concerning community management, the Shirakawa village has established the Resident's Association. Each *kumi*, or district, has a head member that oversees management. These individuals would meet on a monthly basis to discuss local issues including impact from tourism, which will be reported to higher administration. Since tourists can walk around the village, chances of property damage are significantly high, gradually depreciating cultural value. It is essential for the community to raise their voice to maintain order not only within the community but also among foreigners.

Additionally, to lessen the burden of its other association called the Fire Volunteer force, the Resident's Association conducts fire patrol every day. This routine has begun in the 1890s patrolling four times within a day. First 3 patrols of the day are managed at the *kumi* level, which is usually less strict and flexible. However, the higher administration conducts the last patrol of the day. These

[24] Chiho Ochiai, "The Processes and Mechanisms of Community-Based Disaster Management in Shirakawa Village," in *2011 International Symposium of City Planning*, 155-173.

patrolmen would walk around on a predetermined route for an hour. While they are surveying the area, they usually carry around wooden bars called *hyoshigi* to raise awareness of fire risk. These bars are dragged on the ground, making noises that remind and reassure the nearby residents that someone is keeping watch for fire risk. Also, there is a cultural belief that dragging the wooden bars can sever the line of fire created by fire spirits dancing at night. To promote discipline and order, each patrolman must collect stamps at six different stations as proof of diligent work and sign their names on attendance book. If a potential fire risk is found during a patrol, the patrolman issues a "red mark" to the house to encourage fire prevention and neatness around the house. These patrolmen earnestly work because they do not wish to carry the blame when a tragic incident happens. The last task of the Resident's Association is to do a regular maintenance check on water supply system for future fire prevention exercise.[25]

On the other hand, the Fire Volunteer force is responsible for fire prevention and fire extinguishing (Fig. 18). These type of community laborers are known as *ninsoku*, which are workers who do voluntary work; although in most cases they seem obligated. Established in 1924, almost 90% of men in the village have experience as a Fire Volunteer member (Fig. 19). Not only are they the first-responders to fire incidents but also event organizers. For example, when planning for local festivals such as *doburoku* that attracts thousands of spectators, the program must be carefully designed to minimize fire risk. There is also a biannual check-up on houses called Fire Prevention Week in spring and

[25] Chiho Ochiai, "The Processes and Mechanisms of Community-Based Disaster Management in Shirakawa Village," in *2011 International Symposium of City Planning*, 155-173.

autumn. Residents receive a certificate of inspection by the Fire Volunteer force if the house is believed to be safe.[26]

As the village becomes more exposed to technology and modern fire safety standards, there are now water cannons installed just outside *gassho-zukuri* structures. In November, a fire drill check occurs to test if these cannons function properly. They are probably programmed to simultaneously blast water into the air to extinguish fire as well as soaking adjacent buildings to prevent fire spread.

Figure 18. Fire Volunteer Force Outpost. 2016, Gifu. Source: Author.

[26] Chiho Ochiai, “The Processes and Mechanisms of Community-Based Disaster Management in Shirakawa Village,” in *2011 International Symposium of City Planning*, 155-173.

Figure 19. Fire Volunteer Force Members. Gifu. Source: http://kousin242.sakura.ne.jp/wordpress014/

3.4 Decline in Village Practice

The rural-urban migration was another reason why preservation organization was established. The population of younger generations in Shirakawa village is declining which loses the cultural value of *yui* system. In other words, there are less non-disabled people to do traditional activities such as harvesting reeds, thatching, and going on fire patrol. The village community has decided to rely on outside resources to compensate for the loss of labor force. In 2003, the area of *kogaya* production had plummeted to 36,000 m^2, which is less than half the production in 1968. The village responded by purchasing similar Miscanthus reeds called *ogaya* from neighboring towns. Because the diameter of *kogaya* is smaller than *ogaya*, the thatching texture loses its consistency thus looking more clumsy and unprofessional.

Another profound change can be observed in thatching process (Tab. 3). From harvesting to bundling Miscanthus reeds, the number of days to finish these tasks have not changed since the 1970s. However, after the introduction of automobiles, days to transport reed bundles to the designated site has reduced considerably. In 1986, the Gokayama Forestry Association claimed the role of rethatching roof in Shirakawa village. Although it only takes a day for village people to rethatch a single house, it takes roughly 10-14 days for the forestry association to replace half of the roof. What seems more questionable is that this operation did not immediately take action after transporting materials but postponed to next year.[27]

~1970						
Work Description	**Mowing**	**Harvesting**	**Drying**	**Bundling**	**Transporting**	**Rethatching**
Production Rate	1000 m^2 / person • day	80-100 bundles / male • day 70-90 bundles / female • day		250-300 bundles / day	45-55 bundles / male • day (walk) 25-30 bundles / female • day (walk)	
Season	July	October 20	~	~	~	November 1 - 4
Duration	1 day	2 days	Sunny Day x 3	half a day	4-5 days	1 day
1970 ~ 1986						
Production Rate	1000 m^2 / person • day	80-100 bundles / male • day 70-90 bundles / female • day		250-300 bundles / day	600 bundles / day (truck)	
Season	July	October 20	~	~	~	November 1 - 4
Duration	1 day	2 days	Sunny Day x3	half a day	half a day	1 day
1986~						
Production Rate	1000 m^2 / person • day	80-100 bundles / male • day 70-90 bundles / female • day		250-300 bundles / day	600 bundles / day (truck)	
Season	July	October 20	~	~	~	Next Year June - September
Duration	1 day	2 days	Sunny Day x3	half a day	half a day	10 - 14 days
	Gassho-zukuri Residents			Gokayama Forestry Association		

Table 3. Duration of Each Procedure for Thatching. Source: Wada, "A Study on the Maintenance System of Thatched Roofs in Gokayama Ainokura Village, Japan."

Within the concept of *yui*, there is another collaborative organization within the village called Mutual Thatching Association, or *kaya tanomoshikou*. It is a shared effort which a portion of Miscanthus reeds is collected from each household as community storage. When rethatching season draws near, the

[27] Wada, "五箇山相倉集落における茅葺き屋根維持システムに関する研究 [*A Study on the Maintenance System of Thatched Roofs in Gokayama Ainokura Village, Japan*]," 691-693.

respective household provides 70 to 80 percent of the reeds on their own. The Mutual Thatching Association will prepare the remainder. This distribution allows less burden for the household that is undergoing the rethatching process. In 1969, the Shirakawa village established the Gassho-zukuri House Preservation Association that was responsible for securing Miscanthus reeds. However, in 2003 that responsibility was shifted to the Thatched Roof Research facility which was not originated from the Shirakawa village. The Gassho-zukuri House Preservation Association then was given preparation tasks such as setting up platforms for rethatching and managing storages.[28] This re-assignment shows the gradual transition of culturally significant responsibilities from locals to foreign institutions.

According to a survey, the elderly population is not satisfied with the results of thatching by foreign association. The thickness, length, and drying condition of the thatched roof were inconsistent as well as inferior in quality.[29] This issue emphasizes the necessity of *yui* when operating large-scale projects. The Gokayama Forestry Association has abandoned the meticulousness of each procedure like readjusting the entire bundle after moving a strand of reed within. This result not only questions present-day roof maintenance, but also the connection between the building and residents themselves.

[28] Uchiumi, "白川村の「結い」と「屋根葺き替え」の変遷に関する研究 [A Study on the Change of 'Yui' and 'Rethatching' of Shirakawa-mura]," 666-667.
[29] Wada, "五箇山相倉集落における茅葺き屋根維持システムに関する研究 [*A Study on the Maintenance System of Thatched Roofs in Gokayama Ainokura Village, Japan*]," 691-693.

CHAPTER 4: PROJECT GUIDELINES

4.1 Identifying Design Problem

As mentioned in the earlier section of this paper, modern architecture has forgotten the importance of cultural integration. Without this element, buildings can only provide the function of "dwelling" without establishing a deeper connection between culture, buildings, and users themselves. There is often a misconception behind the meaning of cultural integration. Some common mistakes include fixating on the form and materials of the building and directly borrowing these elements from precedents. Although these translations produce the similar appearance of past traditions, they do not encourage the users to engage in communal activities actively. Nowadays there are multi-family residential buildings constructed in urban areas; however, the individual units are preoccupied with their own lifestyle and have a faint awareness that there are other units adjacent to them. The solution to this would be to adopt the "sense of village" from precedent societies that incorporated communal activities as a part of daily life. This will generate situations that require neighbors to collaborate and communicate in fulfilling communal duties.

The design proposal will take place in Japan, so it is ideal also to address issues in this particular region. Japan is reputably known for its rising elderly population and its declining fertility rate, which is an unprecedented phenomenon in industrialized nations. By 1994, the elderly population of 65 and over increased to 14 percent of the total population in Japan, doubling within a quarter

of a century.[30] Consequently, increased number of elderly demands more care institutions, but there is no workforce available to secure these openings, often recruiting foreign workers to compensate. Before 1998, women were responsible for taking care of in-home family members while the husband leaves for work. Today, more than 50 percent of women are employed and prefer to be in labor force rather than taking care of the elderly. Interestingly, the elderly citizens desire to remain independent, so most middle-aged people do not feel obligated to care for them (Fig. 20).[31] According to the bar graph, there is a noticeable decrease in the elderly living together with their children within 50 years. This then raises a question of whether it is safe to grant independence to the elderly population.

[30] Fumie Kumagai, "Forty Years of Family Change in Japan," in *Journal of Comparative Family Studies* 41, Issue 4 (2010), 581.
[31] Yoshiyuki Nagaya and Angela Dawson, "Community-Based Care of the Elderly in Rural Japan: A Review of Nurse-Led Interventions and Experiences," in *J Community Health* 39 (2014), 1020-1021.

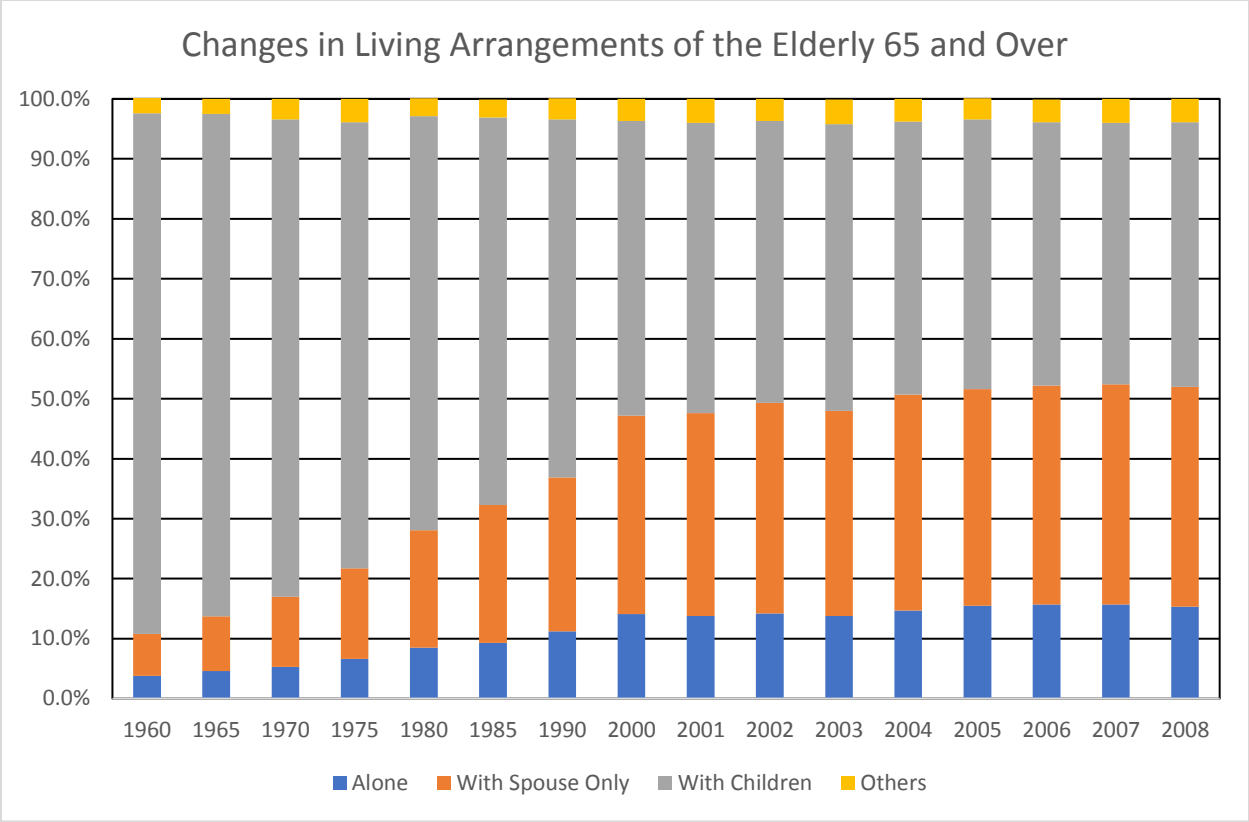


Figure 20. Changes in Living Arrangements of the Elderly 65 and Over, Stacked Bar Graph. Source: Kumagai, "Forty Years of Family Change in Japan."

There seems to be a correlation between individual age and proneness to mental illness. As most elderly socially barricade themselves from outside world, isolation becomes a negative reinforcement for mental illness. This has started to become a major social problem since the 1960s, which demanded more community health nurses and improvement to the Japanese health system.[32] To control the number of cases of elderly with mental illness, Japanese society needs to find a method to prevent social isolation. Namely, there should be programs that enable the elderly to engage in daily conversations and form a social relationship with people.

[32] Nagaya, "Community-Based Care of the Elderly in Rural Japan: A Review of Nurse-Led Interventions and Experiences," in *J Community Health* 39 (2014), 1020-1021.

Judging from the problems identified in Japan, I am proposing a residential community that incorporates the “sense of village” into the design, which promotes an active environment for users to prevent social isolation. Specifically, the proposed program will target elderly residents. However, there should be another element or a medium that strengthens active environment. Instead of elderly people interacting with other elderly, there should be a different age group to stimulate the social environment.

4.2 New Site Conditions

It is ideal for my design to take place in Japan since my cultural integration is inspired by a Japanese vernacular village. Aside from the appropriateness of form and materials, it is essential that the users can appreciate the culture and program spaces embedded into the design. On the other hand, if a project integrated with Japanese culture is built outside of the country, the users may not understand the cultural values thus the use of space becomes less significant.

The new site will be located in Kyoto Prefecture, where I attended Kyoto University for 1 year as a study abroad student (Fig. 21). As I walked through the city during my commute, I noticed the effort in preserving the traditional aspect of Japan, such as their preservation of rowhouses and grid-like urban patterns. Also, the residential district has rows of traditional buildings aligned tightly, leaving no space between each building. It is important to note that these buildings do not have any fire sprinklers installed, so there are fire extinguishers set up along the streets which are available to anyone in case of fire. The streets

networking through residential districts are considerably narrow, providing bare minimum space of single car width. This street condition suggests the main mode of transportation for these residents are bicycles, bikes, and walking.

The site area in particular is positioned south of Kyoto University and west of the famous Kiyomizu Temple. During one's leisure, the individual can stroll to the temple, which only takes roughly 15 minutes of walking. Aside from religious activities, there are also multitudes of traditional stores aligned along the pathway for food and souvenirs. Because the university campus is close to the site, the program should consider dormitory for students as well. Additionally, there are a police station and fire station available within walking distance. In other words, these civic duties can immediately respond to any emergencies. Another possibility is these civic duties could interact with neighbors on a regular basis by organizing programs and lectures that may raise awareness of fire risk. Especially in areas without fire safety compliance, it is necessary for the residents to understand methods of fire prevention.

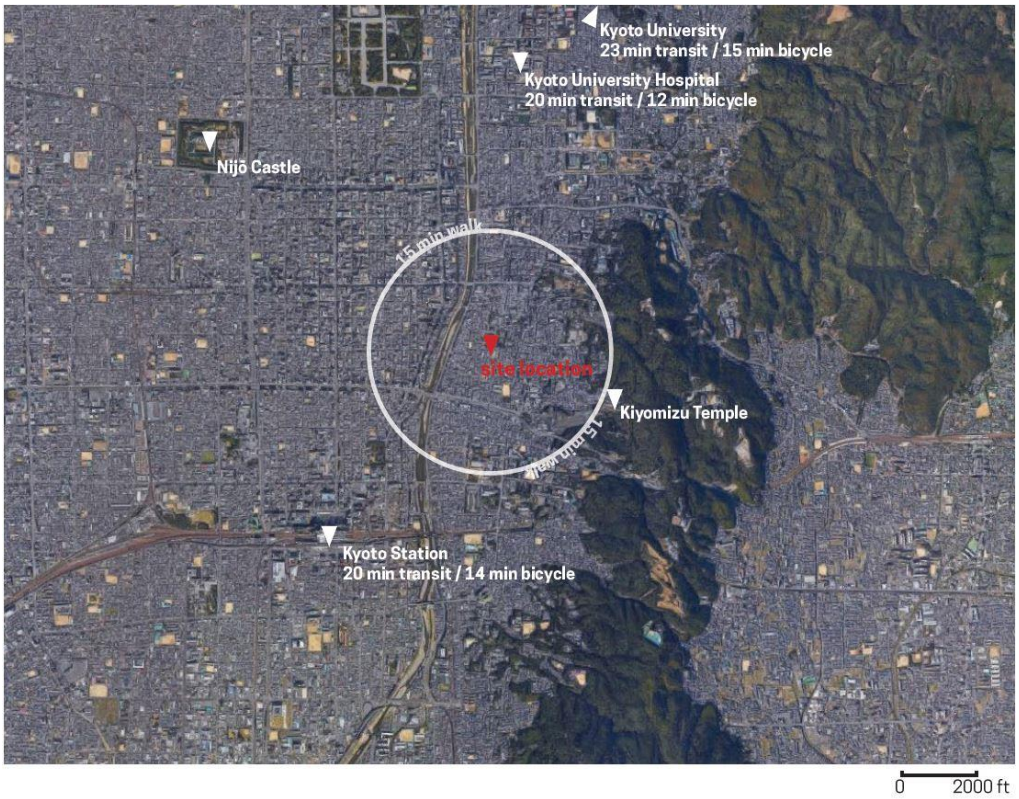


Figure 21. Site Analysis of Proposed Site. Kyoto, Japan. Source: Author.

4.3 General Concept

Before developing the general concept, it is essential to formulate a design guideline for the cultural integration process. This guideline should be applicable in every country in response to diverse cultural contexts. As mentioned in the introduction, the design should not prioritize in traditional form or building materials, but rather the social and community aspect of vernacular villages. Only human interaction can visually express culture; thus, the spatial aspect of the building is more critical in this design process. Therefore, the following design procedure is proposed:

Design Priorities

Priority #1: The Analysis of Modern Residential Community

- Identify the current social or communal problem in the respective region
- Identify what types of communities are present within and near the site
- Declare the occupation and age group of target residents for a better understanding of program requirements

Priority #2: The Aspects of Local Village Community

- Identify unique social or communal aspect that improved the function of the local village
- Propose a unique space or program borrowed from the local village into the new residential community that could potentially be a solution to the communal or social issue on site

Priority #3: The Architecture of Local Villages

- Identify architectural features of the traditional buildings found in local villages
- If applicable, adopt these elements into the modern residential community in response to the climate

Principles & Design Toolkits

Along with the design priorities, it is crucial to consider the five principles for this experimental housing project: Environmental, Safety, Community, Health, and Economy. Environmental principle pertains to using passive design and avoiding toxic chemicals. For Safety, the modern residential community will need to collaborate to overcome shared obstacles. In response to the Community principle, the proposal encourages the residents to share some private space such as restroom and living room. This can further expand to series of communal spaces to connect with neighbors faster. As for Health, the users' mental health will be improved through social interactions and through different combinations of age groups. Lastly, since this proposal is an experimental housing, it will need some revenue to satisfy the Economy principles. Options of renewable energy source and commercial businesses are available as part of the program.

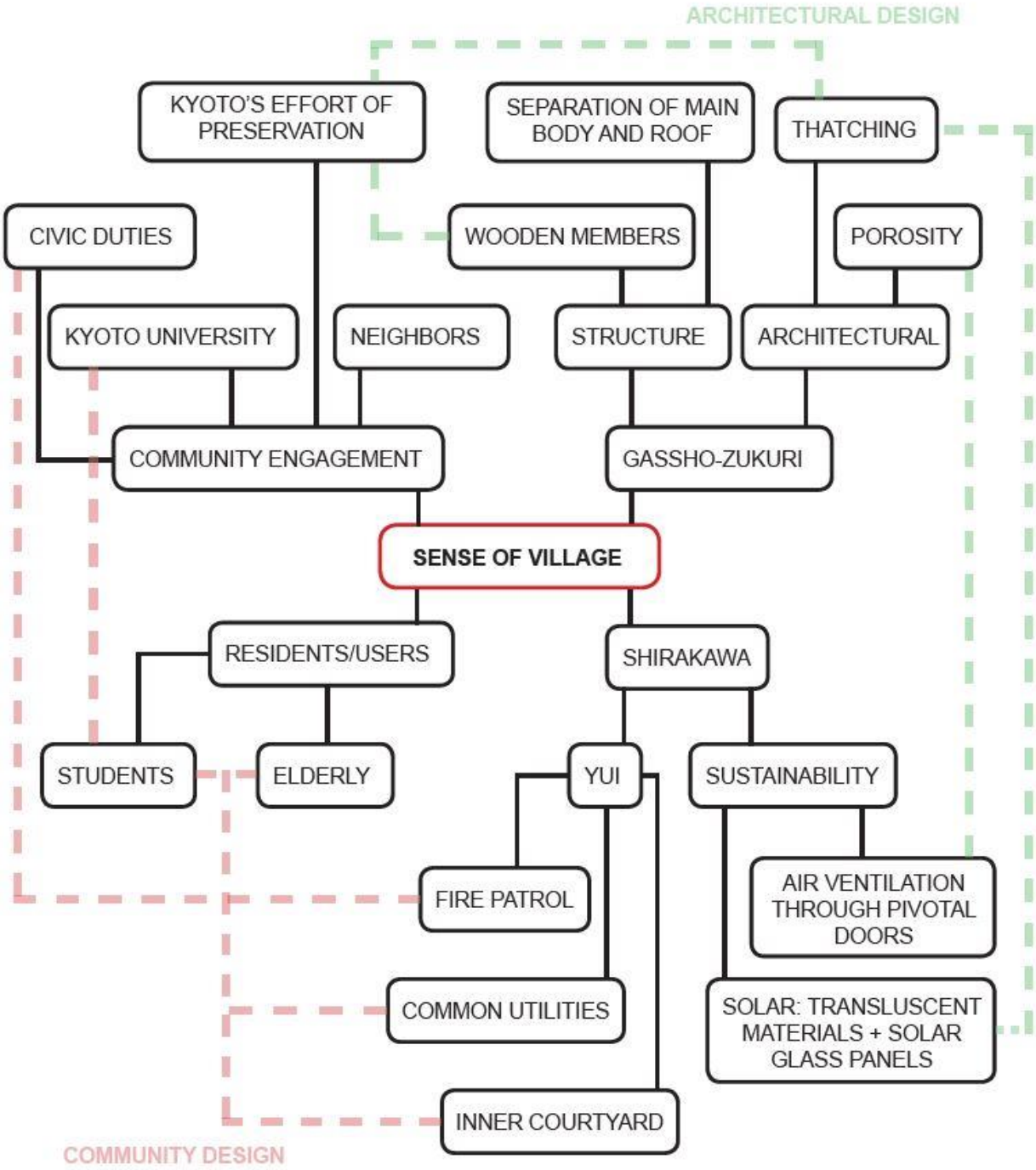


Figure 22. "Sense of Village" Concept, Bubble Diagram. Source: Author.

The simple priority list is a reminder that incorporation of a social and communal aspect of the local village is the top priority in design when tackling a modern communal issue. There are many instances which the community identity has changed due to technological advancement and newly formed governments, which is why this aspect needs to be revisited. After the concept is established from local village community, the design should then proceed to consider the use of traditional architectural elements. The architectural translations will be a supplemental factor to the new residential community, enhancing user experience through microclimatic and spatial effects.

In this research, a “sense of village” is an integration of architectural and communal design that promotes active engagement between and within communities (Fig. 22). As a foundation for this design, the Shirakawa village is an excellent precedent to be analyzed and adapted to modern residential communities. Tackling one of the most discussed topics of rising elderly population and the demand for care facilities, this design proposes a residential building for the elderly and university students. Because the middle-aged population is preoccupied with their occupations, students can have a balanced lifestyle between taking care of the elderly and studying for academics.

This type of program needs to have specific standards of what kind of elderly are preferred in this community. Aside from the age requirement of 65 and over, the elderly are expected to be individuals who do not require 24-hour attention. The objective of this community is for the elderly and students to be able to work together on moderate chores and activities. Also, this program

targets elderly that are currently residing alone, which are vulnerable to social isolation.

As for the students, it is preferred that they attend Kyoto University since it is close to the site. They can commute to class via bicycles or take the city bus, taking approximately 20 minutes for one way. One of the common problems students face is the difficulty of finding an affordable dormitory. Therefore, it might be desirable for the residential community to offer rooms with affordable rent. In exchange, the students could devote some of their time interacting with elderly neighbors and become the social medium. It is understandable that these students must research and write a dissertation, so there should be a log report of minimum hours required to interact. Every day, they can record their hours of interaction, which will later be reviewed by owner of the residential building on a weekly basis.

The residential community should have additional program feature that generates profit or lessens the financial burden to compensate for cheaper rents to students. Two possible ways are either to accommodate commercial space into the program or to take advantage of renewable energy sources. Café is highly recommended in this dense residential district, as it can become a meeting point within neighbors. It should not be fully enclosed to welcome more outside people, which gives an opportunity for the elderly to socialize with neighborhood community. Also, from various available renewable energy, solar energy might be the most efficient source in this site. Most of existing residential buildings are few stories high, so only a small section of the site will be covered by shadow.

The roof should be angled facing east-west orientation to receive direct sunlight during both sunrise and sunset. This solar roof system will provide electricity to the residents, and perhaps have energy reserve that could be sold to the electric company.

When students are spending their time in university, only elderly remain in the residential space. To create more opportunities for engagement, there should be an "Artisan / Craftsmen Corner," a unique space where the elderly interacts with neighbors to talk about Japanese traditions and culture. If the elderly have experience of crafting something simple, then it could be done together with children. Another scenario is for the elderly to reminisce their early lifestyle and raise awareness of the difference between generations in technological, economic, and social perspective. Past experiences can also teach children a moral lesson, which some schools in Japan offer an informal class called "moral education."

In cases where elderly and students are present, several spaces encourage these two groups to make contact. For this design proposal, individual units only contain the basic functions, such as sleeping, storing personal belongings, and changing clothes. This design intention was for residents to leave their rooms as much as possible and use shared spaces. In luxury housing apartment, it appears each unit has every equipment and spaces available to the user. However, this convenience may be a disadvantage to the elderly because they may feel comfortable and will not leave their rooms. Some ideas of shared spaces are the living room, dining room, bathroom, laundry, and

courtyard spaces. To further interact, there should be a predetermined routine within the community which requires teamwork. Inspired by the Shirakawa village, the community should do a fire patrol every night in pairs of a student and an elderly. The obligated task will require communication between the two, which will ideally lead to social conversations as well.

Lastly, since the site is in Kyoto, the overall design should make an effort in preserving traditional practices. In this case, the building will adopt some architectural features from *gassho-zukuri* style houses in Shirakawa village. These elements will translate to modern elements that will benefit the users by providing more natural feeling to the spaces.

4.4 Fire Safety Design

On July 14, 2017, there was a devastating fire incident within the Marco Polo condominium in Oahu, Hawaii (Fig. 23). The fire started in one of the units; however, the investigation team was unable to determine the cause of the tragedy. It resulted in more than $107 million in damage, four residents deceased, and 80 of the 568 units affected. Unfortunately, only the firefighters were extinguishing the fire, as the old building did not have any fire sprinklers installed.[33] After this incident, it raised awareness throughout the people of Hawaii about fire risks and the consideration of improving fire safety systems.

[33] "Investigators Unable to Determine Cause of Fatal Marco Polo Fire," in *Honolulu Star Advertiser*, October 16, 2017, http://www.staradvertiser.com/2017/10/16/breaking-news/live-video-city-officials-announce-marco-polo-fire-investigation-results/.

Figure 23. Marco Polo Fire Incident. 2017, Honolulu. Source: "Investigators Unable to Determine Cause of Fatal Marco Polo Fire."

Professor Kobayashi from the Tokyo University of Science discusses the fire protection regulation in Japan. The Fire and Disaster Management Agency of the Ministry of General Affairs is responsible for the Fire Service Law. It manages the standards of fire extinguishing equipment and fire safety management in both hardware and software. In addition to this regulation, the Building Standard Law was improved approximately 35 years ago, which eliminated the common issue of conflagration.

Conflagration is most susceptible in Asian slums, often resulting in 200 – 300 buildings burning down.[34] As mentioned in the preface of this writing, similar disaster occurred in Ginza and Tsukiji district in Tokyo. The dense residential

[34] Kyoichi Kobayashi, "Some Concerns for Fire Protection Regulations in Asia and Japanese Way" in *Fire Science and Technology* 31, no. 3 (2012): 119-121.

district of wooden buildings became a fuel for the fire to spread quickly. However, the change of Building Standards Law has dramatically reduced the number of incidents of conflagration, which happened only once recently during the Great Hanshin Earthquake. For example, the Building Standards Law enforces the design to consider fire compartmentation, which is a method to isolate the start of fire from spreading further. However, these laws do not apply to existing residential buildings built prior to its establishment. Therefore, in dense residential district such as the designated site, there are fire extinguishers available to the public along the street. The spacing between buildings is also beneficial for the firefighters because they will need to have emergency entrance route for easier access to the source of fire. Although the integration of heavily thatched roof from *gassho-zukuri* style architecture is appealing, this law prohibits the use of combustible material as roofing material. The Building Standards Law is the result of repeated tragedy from past traditional buildings and urban form, which suggests that cultural integration should not be limited to architectural form and materials, but also consider the essence of village lifestyle to promote community engagement and collaboration to prevent fire risk (Fig. 24).

Figure 24. Building Standards Law Procedure. Japan. Source: Kobayashi, "Some Concerns for Fire Protection Regulations in Asia and Japanese Way."

On the other hand, the Fire Services Law focuses on the safety equipment installed throughout the building. The chart shows what types of safety measures are appropriate in every situation from the beginning of fire to the event of conflagration (Fig. 25). Besides the obvious fact that there should be fire sprinklers and alarms set in case of fire, there should be equipment available for the firefighters as well. Especially in a dense residential district with narrow streets, it might not be possible for firefighters to arrive in a large fire truck. In other words, it is necessary to have emergency power outlets, smoke exhausting

system, fire department hydrants, and sprinkler system with hose connection available at the site.

Figure 25. Fire Services Law Guideline. Japan. Source: Kobayashi, "Some Concerns for Fire Protection Regulations in Asia and Japanese Way."

These set of laws need to be considered when designing a residential building in Japan. For the Fire Services Law, it is simply the matter of installing fire prevention systems and equipment within site, which is an addition after the design. As for the Building Standards Law, it will influence the overall design of this project. Because the site is in Kyoto, it is ideal to use wood for major structural members. It is preferable to use heavy timber members for structural

framing instead of artificial materials such as concrete and steel. During a committee meeting at the Kaka‘ako Fire Department on December 14, 2017, Assistant Chief Socrates Bratakos explained that when encountering fire, heavy timber members do not burn down as other smaller wood members would do. Instead, only the outer surface of heavy timber will burn and eventually char, extinguishing the fire through lack of combustible materials. It has the potential to have better fire rating than steel because it doesn’t merely melt when exposed to high heat exposure. Also, using pure timber material will only emit harmless smoke to the users. One of the major concern during a fire is smoke, which depends entirely on what type of material is burning. Harmful smoke might lead to rendering unconsciousness or other negative effects that might prevent the residents from evacuating safely.

In Shirakawa village, the thatched roof of *gassho-zukuri* houses needs to be carefully maintained. While these houses are preserved as the World Heritage Site, preservationists from the village must take precautionary measures to prevent thatch material from igniting. There are large sprinklers positioned throughout the village in case of fire. During the summer, the sprinklers activate every day to apply water on the roof (Fig. 26). By moisturizing thatched roofs prior, the probability of fire greatly reduces. This routine also helps cool the residents from the summer heat.

Figure 26. Daily Water Sprinkler Routine in Summer. Gifu, Japan. Source: https://ikidane-nippon.com/en/interest/shirakawa-go.

Aside from relying on modern fire prevention system, it is also important to note that prior to this installation, the village had fire patrol routines by villagers themselves. To reinforce precautionary measures, the proposed design should also implement the fire patrol routine by the residents. Since a fire station is near the site, there is an opportunity for firefighters to give lectures to the residents regarding fire prevention methods. It is essential for people to be aware of what areas are likely to start a fire. This is similar to a new proposal by the Honolulu Fire Department in Hawaii in response to the Marco Polo incident. In the same committee meeting, Assistant Chief Socrates Bratakos of Honolulu Fire Department revealed their upcoming effort called the Fire Ambassador Program. Although it is still in a rough draft, this focuses on raising awareness of fire risk by giving lectures to AOAO, or Association Of Apartment Owners. The AOAO would then be responsible for informing their residents what they have learned

from the lecture. If the elderly and students are equipped with this knowledge, their daily fire patrol will be more efficient.

4.5 Seismic Design

Earthquake is likely the most difficult natural disaster to predict and prepare. Unlike other natural disasters, it is unseen by the naked eye and people are completely vulnerable when it happens. It is a repercussion resulted from a seismic activity underneath earth crusts. Japan is known for its frequent earthquake disaster due to its geographic location. This region is surrounded by the Pacific, North American, Eurasian, and Filipino plates. As the tectonic plates shift against one another, it builds up stress that eventually releases upwards to the surface, causing an earthquake.[35] With four neighboring tectonic plates, the chances of earthquake increase significantly as well as the scale of magnitude. Consequently, the release of stress from tectonic plates thrusts the water level upwards, generating irregular waves known as tsunamis. Major earthquake events have destroyed many buildings throughout Japan, which is why seismic codes were established and developed. Though the site in Kyoto encounters little or no earthquake in recent years, it is still important to address these factors.

Initially, Japan did not enforce any seismic codes because fire incidents happened more frequently and destroyed more buildings, so the government put more effort in fire regulations. Perhaps the majority of wooden buildings were already resistant to earthquake due to the flexibility of construction materials

[35] Jenny Marder, "Japan's Earthquake and Tsunamis: How They Happened," *PBS News Hour*, March 11, 2011, https://www.pbs.org/newshour/science/japans-earthquake-and-tsunami-how-they-happened

themselves and their connection detail. The consideration of seismic codes began after brick buildings in Ginza and Tsukiji districts, built from the Meiji Restoration Era, were severely damaged by the 1891 Nobi earthquake.[36]

My final design will be a two-story wooden building for several reasons. Kyoto is known for its preservation in traditional buildings, so it is appropriate to be consistent by using wood as a main structural material. Also, because this building is partially residential, wood is an excellent choice to provide warmth to the residents. Compared to concrete and steel, the texture of the wood is more visually pleasing and instinctively feels like home. Lastly, since wood is more flexible than concrete, its structure can withstand the force of earthquake better. Based on personal observation, traditional wooden buildings have loose connections between wood members, which allows the building to sway to disperse the seismic force, similar to how *gassho-zukuri* style houses have thatched roofs with pin joints to disperse wind pressure.

A typical method of applying seismic resistance for wood construction is shear walls with wooden braces (Fig. 27). However, in urban areas where lot space is narrow, it is difficult to build shear walls on both x- and y-direction, which explains how some wooden buildings collapse during an earthquake. These buildings should have plywood or sheathing boards nailed to the frame to compensate for the lack of shear walls. Of course, the joinery is important and may require a metal fastener.[37]

[36] Yuji Ishiyama, *Seismic Codes and Structural Dynamics* (Tokyo: Sanwa-Shoseki, 2008), 10-11.
[37] Yuji Ishiyama, *Seismic Codes and Structural Dynamics* (Tokyo: Sanwa-Shoseki, 2008), 3-4.

Figure 27. Wooden Shear Wall with Braces. Japan. Source: Ishiyama, Seismic Codes and Structural Dynamics.

In 1980, the Building Standard Law Enforcement Order was revised and introduced a new seismic design method the year later. Known as the Allowable Stress and Lateral Shear Capacity Method, this system improves building performance in situations of moderate and severe earthquakes. The buildings should not collapse during the severe earthquake that may harm the users in any way. For conventional wood construction, the design method suggests that maximum height is less than 13 meters, while the eaves are less than 9 meters.[38] Since the proposed building is two-story tall, there is no problem regarding height requirement. Other factors need to be considered, but this research objective

[38] Yuji Ishiyama, *Seismic Codes and Structural Dynamics* (Tokyo: Sanwa-Shoseki, 2008), 22-25.

ultimately aims to show an example of cultural integrated design for residential community.

CHAPTER 5: PRECEDENT STUDIES

5.1 Humanitas Deventer

There is one facility in the Netherlands that offers elderly housing as well as a student dormitory. The Humanitas Deventer is a nursing home that allows university students to live free in the same building complex as elderly residents (Fig. 28). In return, the students must spend at least 30 hours a month as active neighbors in an effort to prevent negative effects of aging. Some joint activities include watching sports, celebrating birthdays, or any interaction that doesn't allow elderly to feel disconnected. According to National Academy of Science of the United States of America, the major cause of mortality for elderly is being isolated from outside world. To compensate, the students will become the medium between the elderly and outside world.[39]

Figure 28. Humanitas Deventer, Exterior. The Netherlands. Source: http://www.humanitasdeventer.nl/.

[39] Carey Reed, "Dutch Nursing Home Offers Rent-Free Housing to Students," *PBS, Public Broadcasting Service*, 2015, https://www.pbs.org/newshour/world/dutch-retirement-home-offers-rent-free-housing-students-one-condition

Humanitas Deventer head Gea Sijpkes began this program in response to the growing elderly population and rising cost of student housing. There were six students living in the building with approximately 160 elderly residents. This arrangement helps reduce staff members as students actively engage communications with the elderly. From their self-published video, it is notable that the university students are always communicating while eating or playing board games. The students would either talk about their recent activities or ask the elderly of their grandchildren. Of course, there is bound to be complaints when two completely different age groups live together. One student mentioned how the elderly neighbors used to complain noises are coming from his room whenever he invited his friends over. However, the complaints soon dissolved after the student started drinking with the elderly instead, whom eventually accepted him.[40] Harmony within the community can be maintained if these groups arrange activities together.

This is extremely relevant to the design proposal because of the integration between student and elderly communities. It is understandable that university students are fixated on their research, which is why roughly an hour a day is sufficient interaction with the elderly. One questionable aspect of Humanitas Deventer is the ratio of students and elderly residents. It appears not every elderly will be guaranteed companionship, increasing the risk of social isolation. However, if the ratio of students and elderly residents is roughly 1:1, each student can be assigned different elderly to socialize with. They can also

[40] Humanitas Deventer, **"**(English) Univé Paludanus Award 2014 'De Woonstudent' - Humanitas Deventer (with English Subtitles)," *YouTube*, 2015, https://www.youtube.com/watch?v=QeQl49tfPfk

mingle in larger groups to familiarize with other neighbors. Consequently, this raises the question of how to sustain financially within the student-elderly community. To compensate for cheaper rent from students, there should be a program amenity that generates profit such as café or multi-purpose room to be rented out by outside party.

5.2 Te Uru Taumatua

In New Zealand, the Tūhoe community requested a community center to be built on a reclaimed land after a long dispute with the New Zealand government. The Jasmax Architects accepted the request and designed the first Living Building in the country. Te Uru Taumatua is mainly constructed from timber sourced from nearby forest approved by Forest Stewardship Council (Fig. 29). As means of sustainability, the building has 390 photovoltaic panels installed as well as the regenerative water-loop system.[41] In addition, the most vital feature of this project was the relationship between clients, architects, and contractors.

Figure 29. Te Uru Taumatua, Exterior. New Zealand. Source: http://www.ngaituhoe.iwi.nz/the-facilities.

[41] BKA Interactive Ltd., "Te Kura Whare," *Jasmax – Tuhoe Te Uru Taumatua*, https://www.jasmax.com/work/tuhoe-te-uru-taumatua/sectors/sustainable-design/2929

The Tūhoe community had many families under poor economic state. When the community leaders claimed to spend their finances on the project, many people opposed and suggested they build newer homes and infrastructures. These families did not have the leisure to pay for renovations; therefore, relying on themselves to repair their homes. After discussion between the Tūhoe community, Jasmax Architects, and Arrow International contractors, they attempted to integrate local people into the project construction phase. Although the involvement of local people will be in the form of volunteering, they will reconnect with the reclaimed land and acquire high-industry level experience for future jobs. Approximately 150 volunteers were gathered and helped contractors make earth brick, which heavily contributed to thermal mass as well as humidity control for the interior setting.[42]

From the development of Te Uru Taumatua, it is apparent that joint effort in construction phase has strengthened the relationship between them. For elderly and students to interconnect, there should be an activity that requires cooperation from both groups. Implementing traditional building method such as manufacturing adobe bricks can not only achieve *yui* but also preserve cultural practices. Since the design proposal will be inspired by Shirakawa village, it is ideal to incorporate traditional building method of *gassho-zukuri* style housing into the program.

[42] *Ever the Land*, directed by Sarah Grohnert (2015; Auckland, New Zealand: Monsoon Pictures International, 2017), PBS film.

5.3 Meme Meadows Experimental House

Kengo Kuma is one of the renowned architects in Japan, known for his application of traditional building methods into contemporary architecture. He tackled the main issue of the validity of bringing back traditional methods such as thatched roof, which is strictly prohibited by present fire codes. If some traditional materials are banned from construction, then one must devise an alternative approach to maintain cultural identity. One of his works, the Meme Meadows Experimental House, is an excellent example of such solution (Fig. 30).

Figure 30. Kengo Kuma, Meme Meadows Experimental House, Exterior Night View. Hokkaido, Japan. Source: ArchDaily, "Même – Experimental House / Kengo Kuma & Associates."

Situated in Hokkaido, Japan, this experimental house was inspired by the traditional *chise* architecture practiced by the indigenous Ainu civilization. The *chise* housing style has both roof and walls covered by bamboo grass as a

thermal insulator. The house is not built on stilts, but instead had cattail mats laid directly on the ground with hearth located in the center. The idea was to warm up the ground itself which will become a natural floor heater.

Although Kuma did not reuse bamboo grass nor cattail mats, he still maintained the essence of vernacular architecture through innovative materials and spatial experience. The overall structure is made from Japanese larch wooden members, cloaked by polyester fluorocarbon coating membrane. Instead of batt or foam insulation, Kuma used polyester insulation recycled from plastic bottles. The inner membrane of the wall is a removable glass-fiber cloth to allow future environmental experimentation. [43] These translucent materials invite natural light while offering privacy to the users. Kuma's intention is for users to adjust their lifestyle to the rhythm of nature and not rely on lighting technologies, similar to how people lived back then.

5.4 Christian Pavilion

In World Exhibition Expo 2000 in Hannover, the GMP Architects built the Christian Pavilion. It is a modular system made from steel construction and can be assembled through insert and screw method. In other words, the pavilion can easily be disassembled to relocate its site. After the Hannover Expo, it was rebuilt in the cloister grounds of Volkenroda in Thuringia.

[43] "Même – Experimental House / Kengo Kuma & Associates," *ArchDaily*, 2013, https://www.archdaily.com/322830/meme-experimental-house-kengo-kuma-associates

The surface materials are either pre-fabricated steel cladding panels or glass panels. Especially in the cloister area, the façade is made of double-paned glass. In addition, the GMP Architects took an innovative approach and filled the cavity of these double-paned glasses with unconventional materials (Fig. 31). Depending on the material property, the façade allows varied lighting into space which complements the feeling of contemplation.[44] The simple structure of the pavilion instead accentuates the materiality of these glass panels to create a unique experience. This creative exhibition introduces a new method of sustainable glass with the opportunity to experiment different infill materials, possibly using recycled materials to raise awareness of waste and pollution problems.

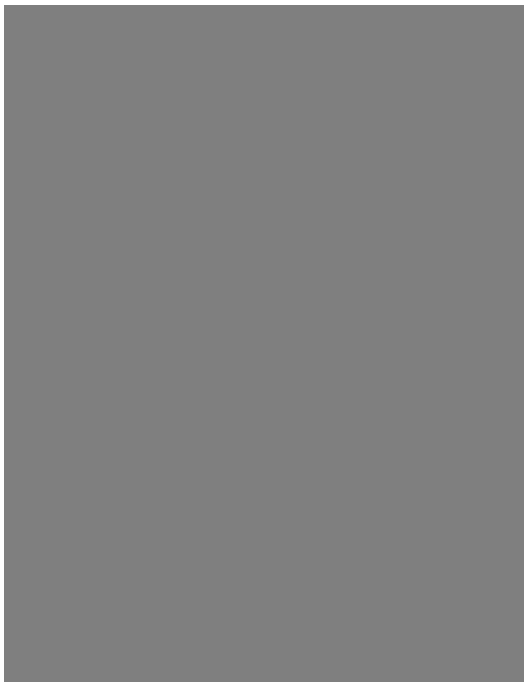


Figure 31. Christian Pavilion, View from Cloister. Hannover, Germany. Source: http://www.gmp-architekten.com/projects/christ-pavilion-expo-2000.html.

[44] "Christ Pavilion, Expo 2000," *Architekten von Gerkan, Marg, und Partner*, http://www.gmp-architekten.com/projects/christ-pavilion-expo-2000.html (accessed December 7, 2017).

The idea of infilling the cavities of double-paned glass is truly innovating and can be used in cultural context. This approach is applicable in Japan because of extreme climate change like Germany. While double-paned glass is used for thermal insulation, the infill material can be a material derived from *gassho-zukuri* architecture. It would be ideal to insert Miscanthus reeds as infill materials for interesting lighting effect. Because the cavity space is narrow, it might be preferable to use *kogaya* reeds instead of the wider *ogaya* reeds. Relevant to the issue of using *ogaya* for thatched roof, using wider reeds create inconsistency and is visually unappealing. The cavity space also does not have enough flexibility to overlap *ogaya* reeds, but it might be possible if *kogaya* reeds are used.

CHAPTER 6: DESIGN PROPOSAL

6.1 Design Process

Figure 32. Site Plan, Figure Ground. Source: Author.

Shown above, the proposed site has an area of roughly 2,470 m^2. Most of the building blocks are residential, which means incorporating commercial spaces into the program can stimulate the community engagement with the elderly residents. The site is positioned at the intersection of two main roads, so the commercial space should be positioned adjacent to them (Fig. 32). The program spaces for this residential community are as follows:

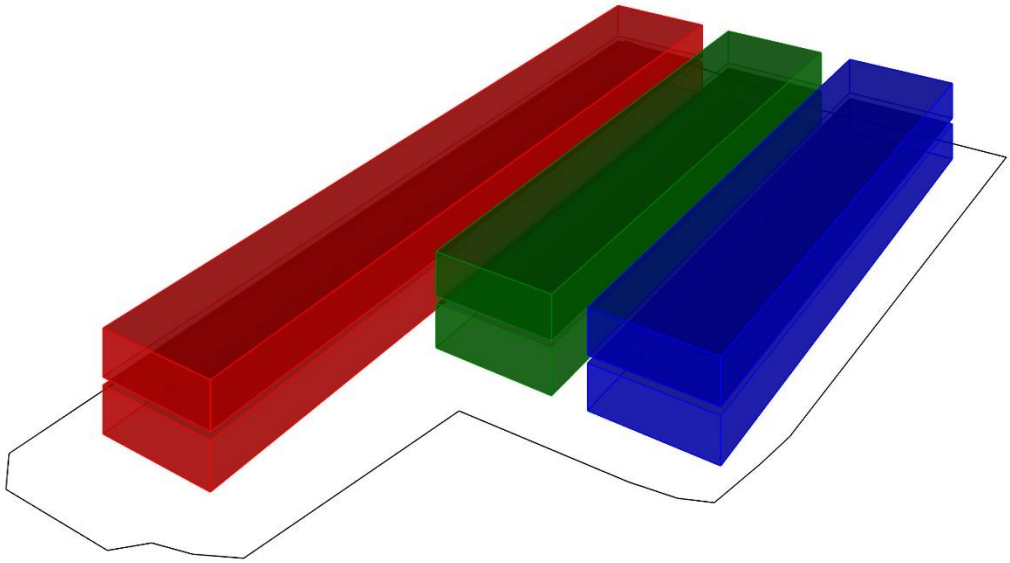


Figure 33. Diagram of Program Spaces, View from Northwest. Source: Author.

Red (Public):

Café, Artisan / Craftsman Corner, Lobby, Office, Garden Terrace

Green (Private):

Individual Residential Units, Shared Bathroom and Water Closets

Blue (Semi-Private):

Living Room, Dining Room, Kitchen, Nursery, Laundry, Study Room

The spaces should be divided clearly between public, private, and semi-private spaces (Fig. 33). By establishing clear boundaries, the elderly residents will have better awareness and usability of their new homes. The private units are in the center of the community for easier access to both semi-private and public spaces. The voids between each space can be converted to courtyard spaces for greenery and leisure.

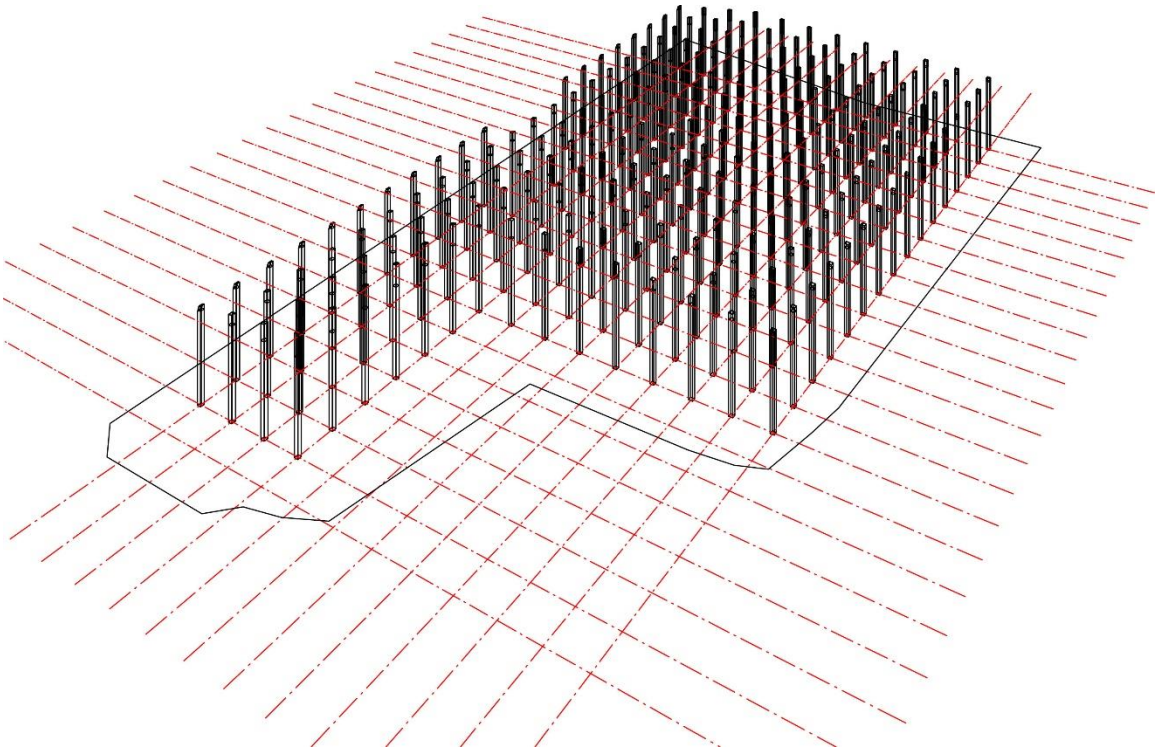


Figure 34. Heavy Timber Column Layout on Grid, View from Northwest. Source: Author.

Since the spatial layout is generally shaped as rectilinear mass, the column placement can be simple. The diagram shown above is a series of heavy timber columns constructed equidistant from one another in a grid format (Fig. 34). This allows easier instruction for building the bottom half of the structure, and more effort can be placed on the roof. Because the bay of each column interval is consistent, it should be less difficult in determining how the spaces should be distributed, like the modular system of tatami mats. On a side note, the exact dimensions of heavy timber column are not calculated because it is not within the scope of this project. As a reminder, this project focuses on the communal, spatial, and social aspect, instead of its structural feasibility.

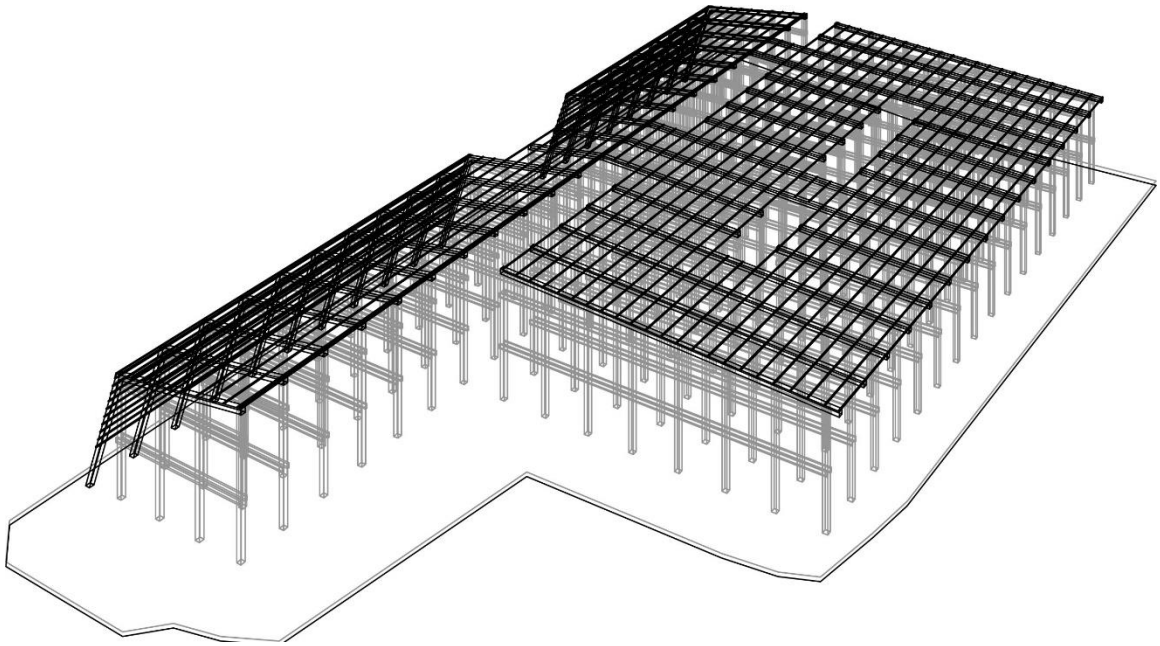


Figure 35. Sloped Roof Enveloping the Entire Community, View from Northwest. Source: Author.

It is ideal for a single roof to envelope three main spatial masses as if defining a single and cohesive community. The roof surfaces are facing east-west for the potential harvest of solar energy (Fig. 35). Usually, the roof should face south for constant exposure to the sun; however, there is a large residential building towering south of the site, which blocks sunlight most of the day. The entire roof system will be covered with either polycarbonate panels for light diffusion, or solar glasses for collecting renewable energy. There are several linear voids within the roof surfaces as visual indicators of where the inner courtyards are located. By having openings above the courtyard spaces, users will feel more liberated vertically. Compared to Shirakawa region, Kyoto does not have extreme snow accumulation, so there is no concern of roof collapse. In fact, during my one-year study abroad program in Kyoto, I rarely saw any visible snow on the ground.

6.2 Architectural Drawings

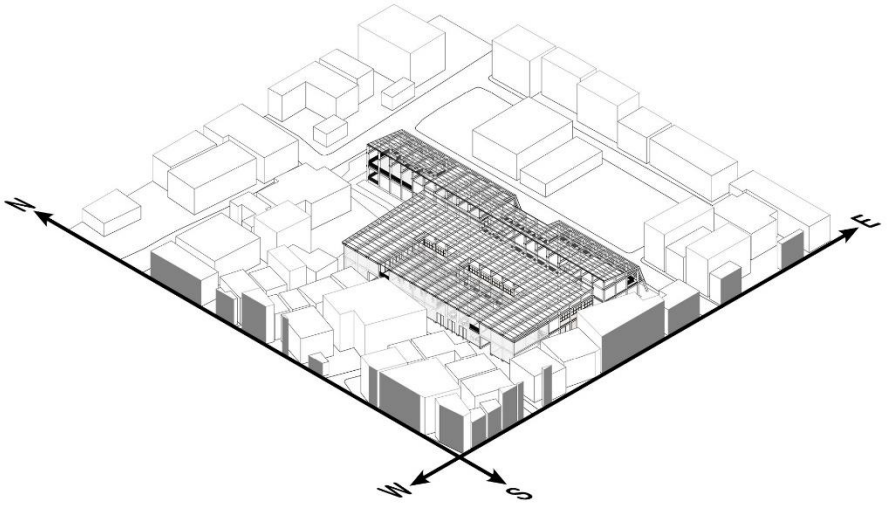


Figure 36. Site Plan, Isometric View. Source: Author.

Although the project seems enormous compared to surrounding context, the eastern portion of space is reserved for commercial and public uses as means to connect to the outer community. In other words, the residential community itself is the rectangular box adjacent to the commercial and public space. From an aerial view, its mass may intimidate people; however, when viewed from street level, these buildings are broken into three major spaces which are less intimidating (Fig. 36). To further alleviate the visual discomfort, some areas will have translucent materials as finish surface to connect with the surrounding while maintaining privacy.

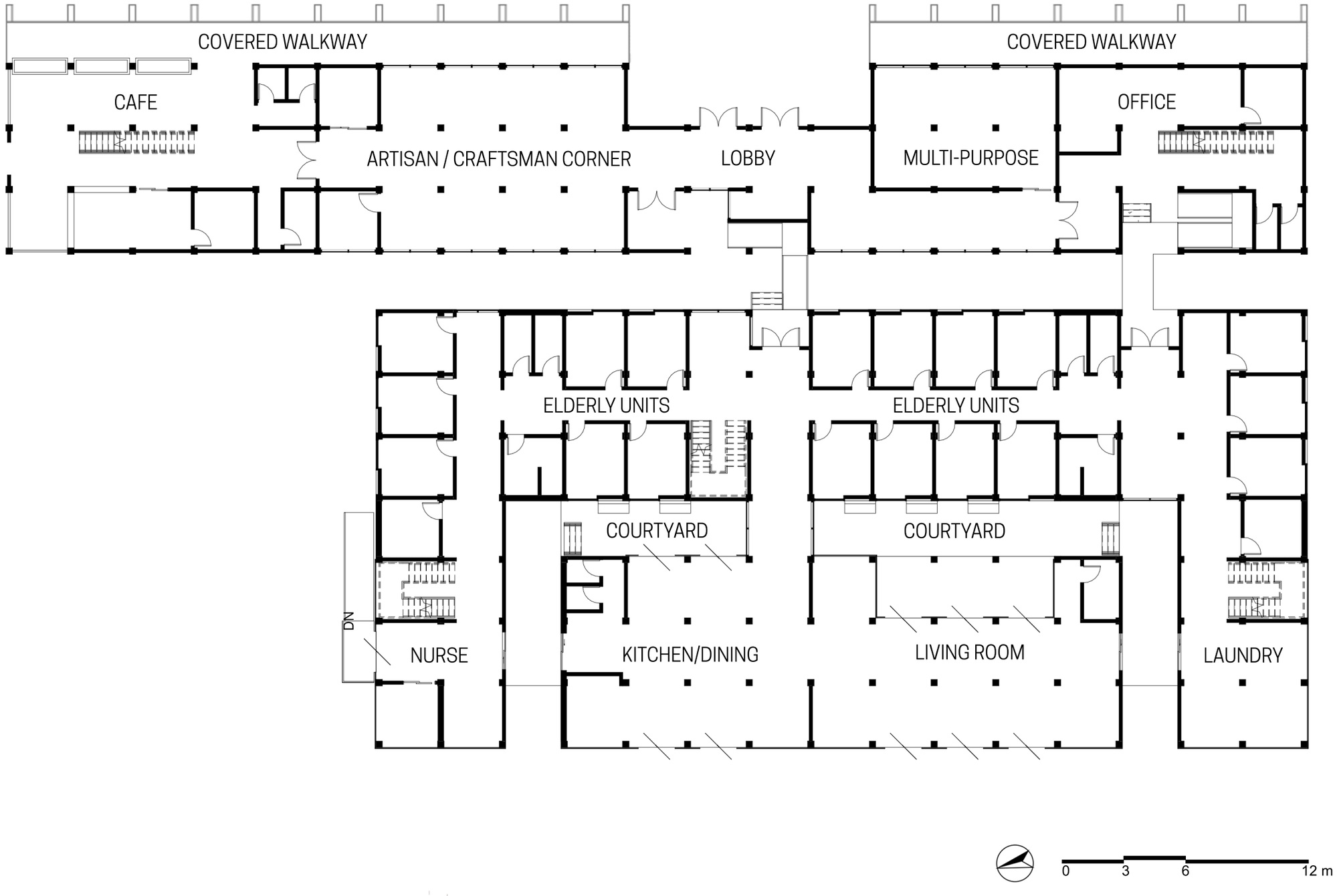


Fig. 37. First Floor Plan. Source: Author.

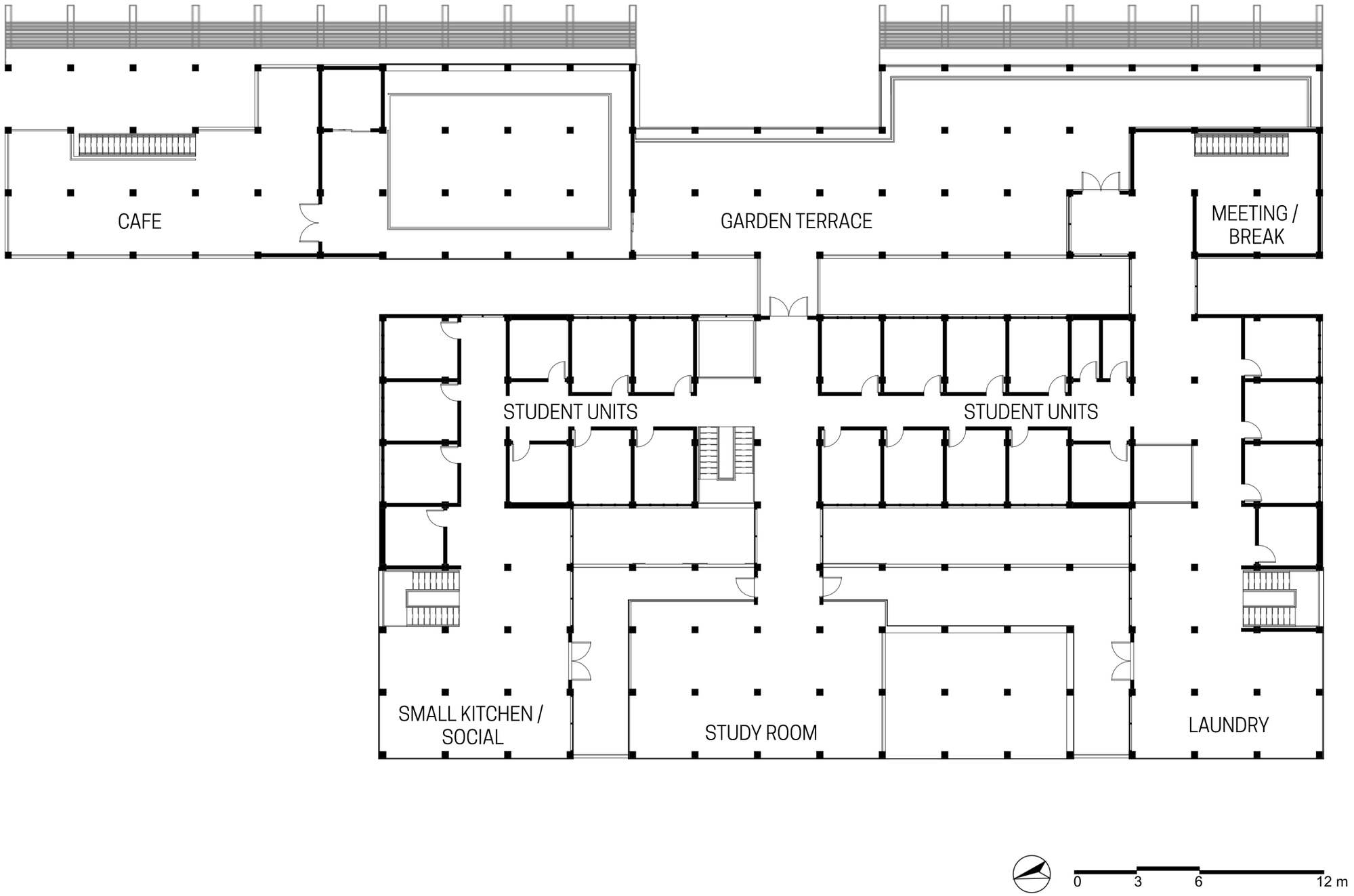
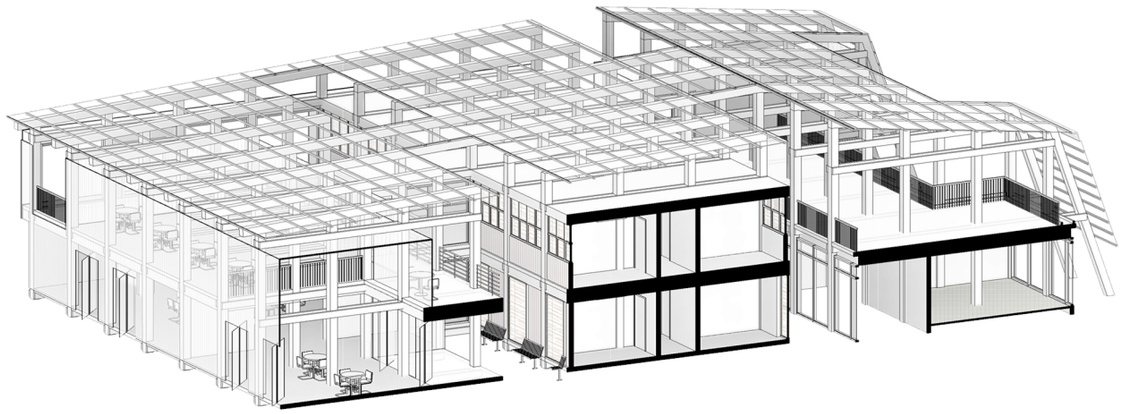
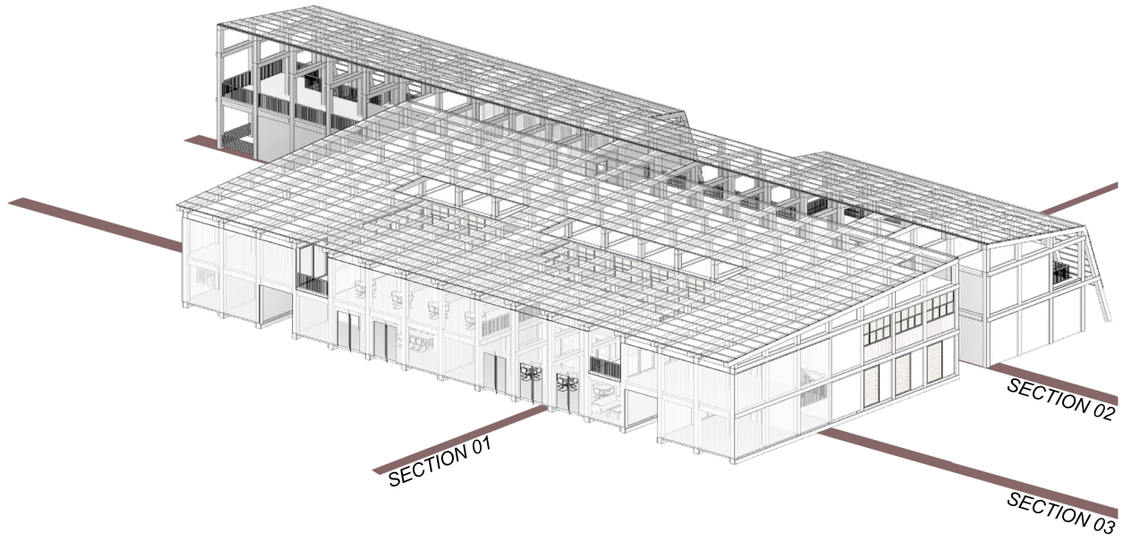
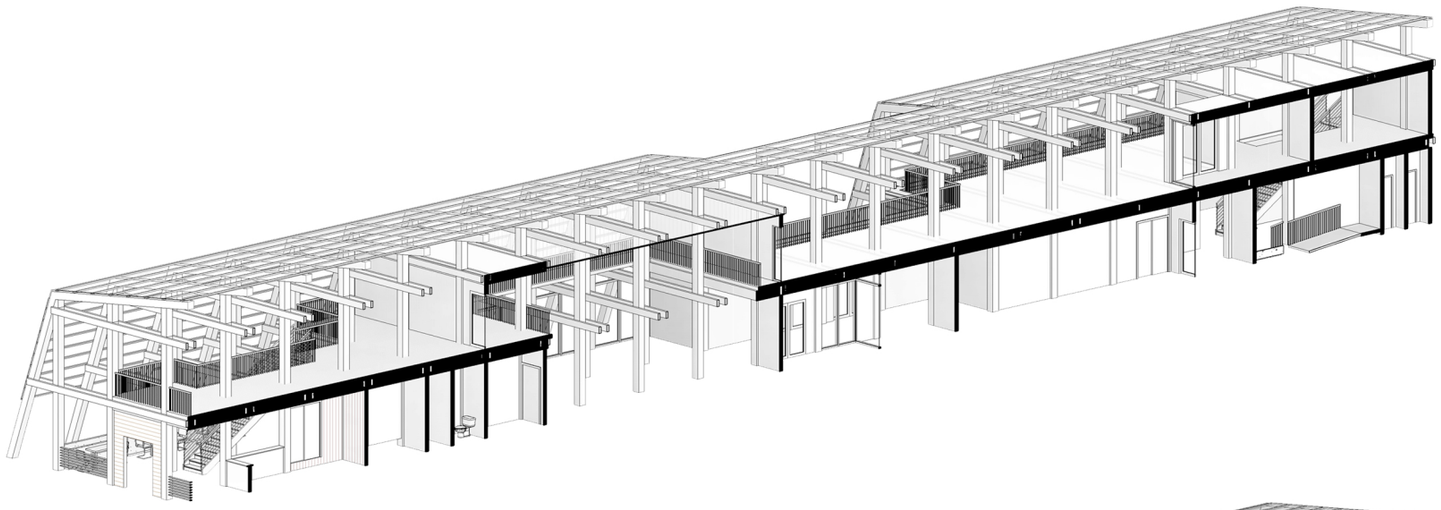


Fig. 38. Second Floor Plan. Source: Author.



SECTION 01





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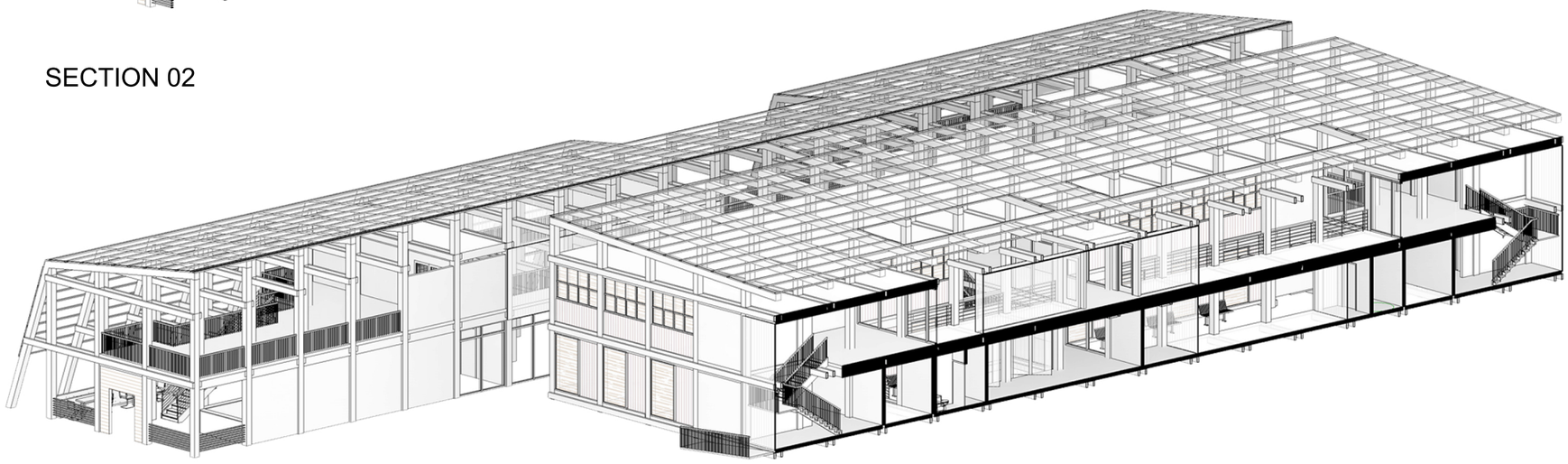


SECTION 03

Fig. 39. Section Perspective Drawings. Source: Author.

Figure 40. East Elevation, Not to Scale. Source: Author.

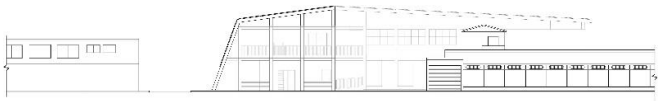


Figure 41. North Elevation, Not to Scale. Source: Author.

6.3 Room Models

Figure 42. Residential Unit for Elderly, Perspective. Source: Author.

Elderly Units

All elderly units are located on the first floor for easier access to shared spaces. Each unit only offers the functions of sleeping and changing clothes. The sleeping area has a tatami flooring for flexibility in the use of space (Fig. 42). The thick wall in the middle has built-in storage for *futon* or mattresses. Every morning, the elderly can fold their *futon* and store it away to start the day. This exercise alone can lead to a healthier lifestyle as well as raise alertness of their surroundings. These units also have sliding windows which are directly

connected to inner courtyards or other green spaces. The residents can open their windows and sit on the edge of the flooring for leisure.

Figure 43. Residential Unit for Students, Perspective. Source: Author.

Student Units

Similar to the elderly units, the room layout for students only has basic functions including personal workspace. The thick wall in the middle can be a built-in shelf for immediate reach. As opposed to the *futon* idea for the elderly, the students should have bed furniture for quicker preparation to start their

school day (Fig. 43). Because student units are on the second floor and their personal workspace is against the window openings, fixed windows are used instead as a replacement.

Movement and Health

It is imperative to create many shared spaces in the community to promote social interaction among the residents. In other words, each private unit should only contain the most basic functions of sleeping and storage for personal belongings. This means that residents would only go back to their rooms for limited occasions. Instead, they are expected to spend their time in shared spaces, where residents can do similar activities together.

In most multi-family housings, each unit already has full amenities to satisfy daily needs. Although it seems that such service is considered a bare minimum to the society, the convenience can sometimes have drawbacks depending on the user profiles. Specifically, if the elderly residents were given a room with full amenities, then they do not require leaving their rooms frequently. As a result, they are prone to social isolation which increases the risk of mental illness. Therefore, following room models are proposed for both elderly and university students.

6.4 Modern Village Life

Time	Students	Elderly
6:00 am		Waking up; folding their *futon* sheets. Stretching.
7:00 am	Waking up; Breakfast	Breakfast
8:00 am	Commute to university	Free time [1]
9:00 am	Class / Studio / Study	Moderate chores: sweeping floor, picking up debris in the inner courtyard, watering plants
10:00 am		
11:00 am		Free time
12:00 pm	Lunch in university	Lunch in Dining Room
1:00 pm	Class / Studio / Study	Free time
2:00 pm		
3:00 pm		Artisan / Craftsman Corner [5]
4:00 pm	Free time [2]	
5:00 pm		Free time
6:00 pm	Dinner in Dining Room	Dinner in Dining Room
7:00 pm	Social Interaction [3]	Social Interaction
8:00 pm	Fire Patrol [4]	Fire Patrol
9:00 pm	Free time	Preparation for sleep
10:00 pm		Bedtime
11:00 pm		
12:00 am	Bedtime	

Notes:

1. Free time for the elderly generally includes reading newspapers, watching television, taking a nap, or meeting friends and families from outside community.

2. Free time for university students includes club activities and spending time with classmates.

3. Social Interaction can be done any time of the day, as long as the student spends time with the elderly for at least an hour a day, excluding breakfast and dinner time.

4. Fire Patrol routine will require only a pair of a student and elderly each night. Therefore, other residents have free time.

5. Artisan / Craftsman Corner should be held in the afternoon when children are available for more interaction between different age groups.

Table 4. Typical Weekday Schedule of University Students and Elderly. Source: Author.

It is important to respect the personal lives of both university students and the elderly. Therefore, students should have time to study and socialize with their classmates, while the elderly should have periods of free time to relax (Tab. 4). The following renderings show examples of space which create opportunities for interaction between inner and outer community, and university students and the elderly residents themselves.

Figure 44. Covered Walkway Along the Side Street, Revit and Photoshop. Source: Author.

Covered Walkway

Along the side street, there will be covered walkway in response to harsh sunlight in the morning. The roof material is polycarbonate panels which diffuse incoming light for comfortable walking experience (Fig. 44). As pedestrians walk along this space, they can witness activities within public space such as café and Artisan / Craftsman Corner. This is relevant to how *koya* structures utilized its corner spaces as storage and suspended bed. Instead, this unique space will be used as a comfortable walkway that connects the circulation of residents and neighbors. The flat surface of the roof translates to the same language of dense residential fabric.

Figure 45. Artisan and Craftsman Corner, Revit and Photoshop. Source: Author.

Artisan and Craftsman Corner

This is one of the most important space regarding the relationship between the residential community and neighborhoods. It allows the elderly residents to leave their private space and interact with neighbors. Not only could the elderly pass down knowledge of traditional crafting or exhibiting their expertise, but also simply converse with younger generation about their past experiences (Fig. 45). Younger people, especially elementary school students, can potentially gain moral lessons from this storytelling, which is supplemental to their school curriculum. From personal experience, most elementary schools in Japan require students to take Moral and Ethics course to guide them to success in the future properly.

Figure 46. Living Room, Revit and Photoshop. Source: Author.

Living Room

In the western end of the residential community is a living room surrounded by polycarbonate panels. Like the covered walkway, the facade allows soft lighting effect throughout the day. Elderly residents can spend their time in this space for leisure as well as socially interacting with other residents or visitors. In addition, there are polycarbonate pivotal doors on both sides of the room for maximum ventilation, as the predominant wind mainly blows from the west (Fig. 46). By fully opening these doors, the living room connects the outdoor space with an inner courtyard.

Figure 47. Inner Courtyard, Revit and Photoshop. Source: Author.

Inner Courtyard

These linear green spaces within the residential community provide private outdoor experience for both elderly and students. The inner courtyards are adjacent to individual units of the elderly for easy access. They can simply slide their doors open and sit on the edge of the flooring for leisure. Seating along the courtyard is for students to sit and socially interact with the elderly casually (Fig. 47). Every morning, the residents can routinely water the plants as well as pick up any debris carried by the winds. This can be an alternative form of exercising and another opportunity of shared labor activity.

Figure 48. Study Room for University Students, Revit and Photoshop. Source: Author.

Study Room

Since the university students are constantly required to study for exams and research for the dissertation, it is essential for the community to provide a study room. Located on the second floor, this space is also surrounded by polycarbonate panels, preventing direct sunlight to the books as well as a visual distraction from outdoors (Fig. 48). It is spatially connected to the living room downstairs for opportunity of conversation between students in upstairs and elderly residents in downstairs. This was inspired by the porous flooring of *gassho-zukuri* style housing which allowed heat to circulate throughout all floors. However, in this case, the porosity encourages vertical communication between floors.

Figure 49. Garden Terrace, Revit and Photoshop. Source: Author.

Garden Terrace

Above the lobby area is a garden terrace that receives maximum solar exposure through transparent roofing. The elderly can also access this space through hydraulic elevator located in the Artisan and Craftsman Corner. Residents can potentially grow plants that can be harvested for the café to use as ingredients or arranged as a boutique for small gifts (Fig. 49). The collected plant materials can be transferred to the Artisan and Craftsman Corner for a quick flower arrangement event. The sloped roof not only prevents snow from accumulating on garden plants but also collects renewable energy through the application of solar glasses.

Fire Patrol Duty

Every night, a pair of student and elderly go through a routine of checking fire safety of their homes. The checklist will serve as a guideline for them to be cautious of several points (Fig. 50). Once it is completed, it will be reviewed and approved by the Apartment Owner of this residential community. By writing their names on the checklist sheet, they will feel more responsible for this duty.

This program is modified from the traditional fire patrol system in Shirakawa Village. For strict routine, the fire patrol member had to sign their names in several posts throughout the village as proof of discipline. When an individual is assigned to this task, it generally means he is acknowledged as part of the village. Similarly, elderly and student residents will need to do fire patrol for the community to be acknowledged as a member. While the pair inspects their homes, they will be in a situation which requires communication to fulfill their duties. By communicating, the elderly and student will form a stronger bond between them, eventually transitioning from necessary communication to social interaction. Once all the residents take part of the fire patrol, the pairs can be reshuffled to establish a stronger relationship with more people.

FIRE PATROL CHECKLIST

DATE _____

STUDENT _____

SENIOR _____

APPROVAL BY AOAO

GENERAL

- ☐ Check expiration date on fire extinguishers
- ☐ Clear dust from electrical outlets
- ☐ Check for any abnormality in incandescent light bulbs if used
- ☐ Plugged outlets should not be hot

HALLWAY

- ☐ Sweep off visible dust and clear debris
- ☐ Doors of residential units are closed
- ☐ Exits must not be blocked
- ☐ Exit signs are lighted

KITCHEN

- ☐ All kitchen appliances are off (except refrigerator and freezer)
- ☐ Unplug portable heaters (ex. water heater, toaster, etc.)
- ☐ Avoid combustible materials near heat sources

LIVING / DINING

- ☐ Electrical wires are not under a rug or carpet, and not under furniture

COURTYARD

- ☐ Pick up any used cigarettes off the ground

STUDY ROOM

- ☐ De-clutter near the entrance / exit
- ☐ Extension cords not used as permanent wiring.

LAUNDRY

- ☐ Clean dryer lint after every use

COMMENTS:

_____

_____

_____

_____

Figure 50. Example of Fire Patrol Checklist. Source: Author.

CHAPTER 7: DEVELOPMENT

7.1 Products and Manufacturers

Glass Panels from OKALUX

OKALUX is a German glass company that provides unique products to enhance the user experience. While a member of German Sustainable Building Council, its innovative approach is to utilize the cavity between insulation glass for aesthetics and lighting conditions. Within their collection, OKAWOOD is the most appropriate selection for this project. As the name suggests, the window frames are made of wood harvested from sustainable forests.[45] In addition, default of cavity input is a series of horizontal wooden slats positioned according to the sun angle (Fig. 51). This allows warm tinted light to enter the interior and protects the user from glare.

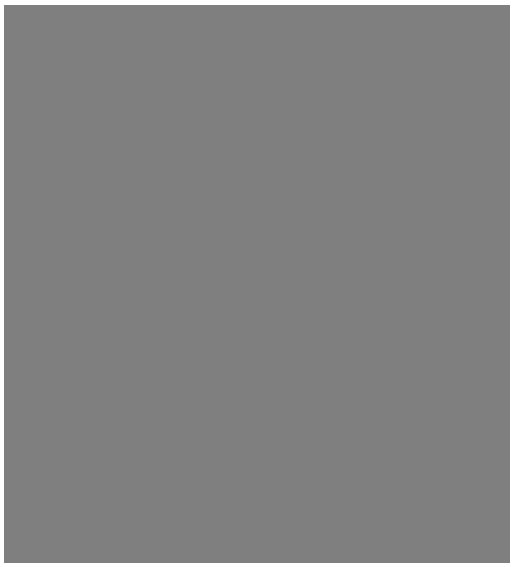


Figure 51. OKAWOOD Window Panels, Interior View. Source: OKALUX, "OKAWOOD: Glass With Functional Timber Insert.".

[45] OKALUX, *OKAWOOD: Glass With Functional Timber Insert* (Marktheidenfeld, Germany: Author, 2014).

This product may not be appropriate in tropical climates but is applicable in Japan where it has similar climatic conditions as Germany. In addition, the warm feeling from the OKAWOOD frames synergizes with the overall wooden residential building. The warm texture will create a more “home-like” atmosphere for the elderly and students. Instead of inserting wooden slats into the cavity, Miscanthus reeds will be used for light diffusion and vernacular sensation. The experimentation of using unique materials within the cavity is inspired by the Christian Pavilion, which was one of the precedent studies in this research. These window frames are particularly installed in each of the residential units, either as fixed or sliding windows. When residents wake up in the morning, it would be elegant and peaceful if the first thing they see is a soft diffused light with textures of a thatched roof, just as the experience of waking up in an actual *gassho-zukuri* style house.

Solar Panel Glass from Voltarlux

To sustain a residential community with cost benefits for residents, it is essential to have a source of revenues. Aside from implementing a café program into space, the building should have a system to utilize renewable energy source, particularly solar energy. Since the community will be enveloped by a glass roof, it is a perfect opportunity to use solar glasses. Voltarlux is another German company that specializes in skylight system that harvests solar energy. It has a thin-layered silicon technology on the glass sheets which converts sunlight to direct voltage while allowing sunlight to illuminate the space below. This

application also functions well in overcast weather.[46] The most efficient way to harvest energy is for the solar glass to be positioned perpendicular to the sun angle. However, at the same time, this would mean the residents are exposed to harsh rays of sunlight, especially in summer time. Fortunately, the array of solar cells on the film makes the glass look tinted, which the residents will feel cooler from a visual perspective (Fig. 52).

Figure 52. Voltarlux Solar Panels are Tinted, Exterior View. Source: http://www.raumprobe.de/material/glaswerke-arnold-gmbh-co-kg/voltarlux/datenblatt/.

Insulated Translucent Facade Using Aerogel

Inspired by Kengo Kuma's experimental house in Hokkaido, there is a space within the community enveloped by translucent sheets. This area is mainly used as living and dining room, a common gathering space for the elderly

[46] "Photovoltaic (PV) Units," *EUglass*, 2008, accessed January 31, 2018, http://www.euglass.com/photovoltaic.html.

and university students to interact. The facade invites diffused sunlight into space that improves their comfort during leisure. The translucent sheets are mainly polycarbonate panels with rectangular cavities. When light passes through this panel, there are only faint traces of vertical ridges from the panel cavities (Fig. 53).

Figure 53. Translucency from Polycarbonate Panels, Interior View. Source: https://www.dezeen.com/2013/12/05/translucent-house-with-plastic-walls-in-tousuienn-by-suppose-design-office/.

However, using only polycarbonate sheets does not maintain thermal comfort within interior space. Therefore, another element needs to be added for

thermal insulation. Aerogel was invented more than 80 years ago by Dr. Samuel Kistler and was used for industrial or building insulation purposes. It utilizes silica gel, which the liquid component is replaced by gas to make the overall product significantly lighter in weight. For visual purpose, it is a complex network of solidified bubbles, creating nanopores with gas inside. If compressed, the volume of silica bubbles is only 3% of the original volume. The silica material itself are poor conductors, so it creates a repetition of thermal transfer in a nanoscale.[47] In other words, the heat cannot be invaded or escaped from both exterior and interior space, respectively.

Wooden Nails from Lignoloc

As discussed in other sections of this research, the residential building will mainly be constructed of wood. Along with the use of heavy timbers, it is ideal to look for other products that complement the warm feeling. Normally, wood construction uses aluminum nails at joineries; however, having many metallic surfaces exposed to the users might disrupt the warm feeling emitted by wood members. In addition, if a fire were to happen in this building, burning aluminum nails releases toxic fumes that may harm the escaping residents. It would be less harmful if wooden nails were burnt because they only produce natural smoke. This is similar to the use of *wakugi*, or wooden nails, in *gassho-zukuri* style houses.

[47] "About Aerogel and Aerogel Insulation," *Aspen Aerogel*, 2001, accessed January 31, 2018, https://www.aerogel.com/resources/about-aerogel/.

Lignoloc is the first wooden nail manufacturer for future industrial and ecological timber construction. Although it is still in the process of patenting, experimentation by the development team shows many promises compared to regular aluminum nails. For example, using metal fasteners at joinery creates differentiation in thermal expansion rate, sometimes leaving a trace of corrosion on wood. Lignoloc nails are made from beech wood, which has similar tensile strength as ordinary nails. For the wood nails to interlock wooden members, it does not require pre-drilling for insertion. Instead, Lignoloc relies on the concept of lignin welding, which is a unique welding method developed in 1998.[48]

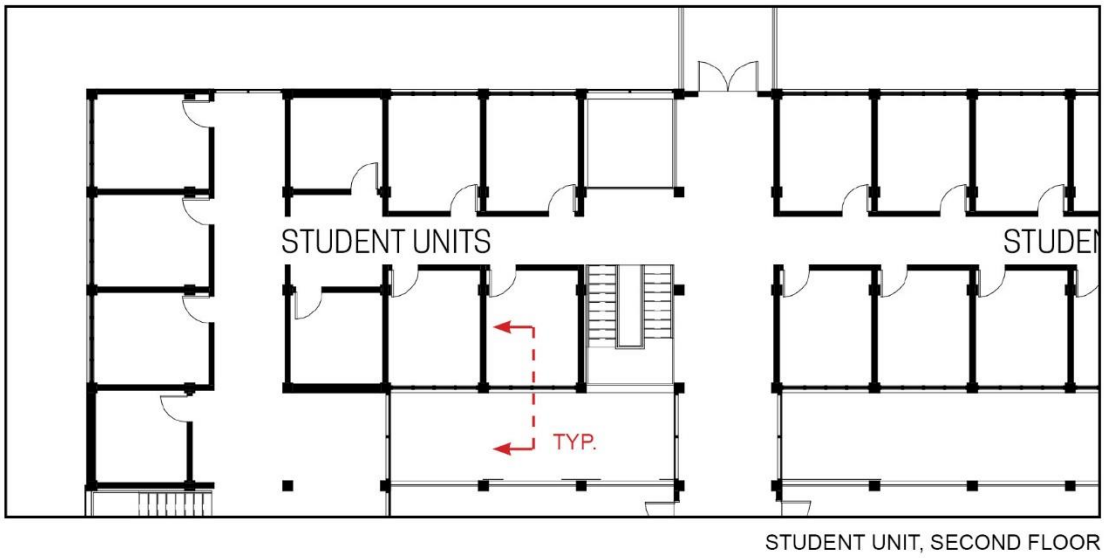
Lignin welding is when wooden nails generate large frictional heat when driven into a wood surface, welding with surrounding wood in the microscopic scale. Beechwood is ideal in this case because the cell structures are usually homogenous that results in consistent welding. Using the pneumatic nailer, the welding condition depends entirely on how fast the nails are driven, which determines the amount of frictional heat produced (Fig. 54). The nails are also permeated with resin for increased durability in outdoors. Lastly, beech wood is an indigenous and renewable material, so it is considered sustainable. Some applications include interior cladding system, furniture crafting, and pallet production.

[48] Beck Fastener Group, *Lignoloc: Collated Wooden Nails* (Mauerkirchen, Austria: Author, 2017).

Figure 54. Wooden Nails and Pneumatic Nailer, Lignoloc. Source: Beck Fastener Group.

Since it seems that Lignoloc wooden nails have not yet been tested between wooden structural members, they will only be applied to architectural woodwork. Most of flooring and wall material will be wood, so the construction will be easier and faster. If wooden nails were used to bolt sheathing boards onto wooden structural members, the entire system might act as a functional shear wall. When these woodworks need to be replaced, the old parts can be recycled without needing to separate aluminum nails. Therefore, metal fasteners are used between structural members, whereas Lignoloc wooden nails are used for architectural purposes. Fortunately, most metal fasteners are covered by architectural element, so they are not visible to the users.

7.2 Details



STUDENT UNIT, SECOND FLOOR

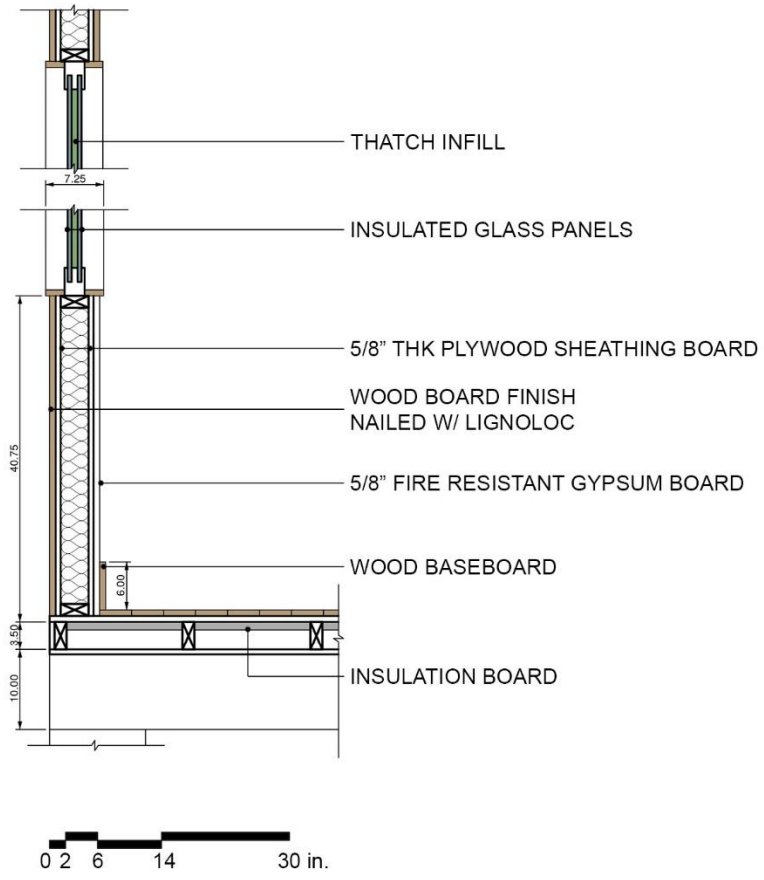
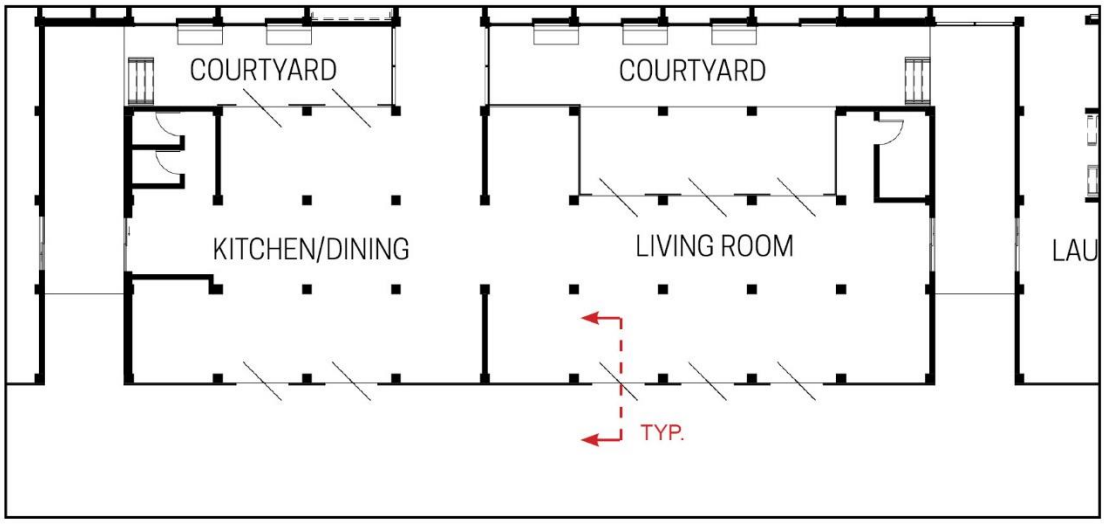


Figure 55. Detail Draft of Window with Thatch Infill. Source: Author.



PIVOTAL DOORS, LIVING ROOM

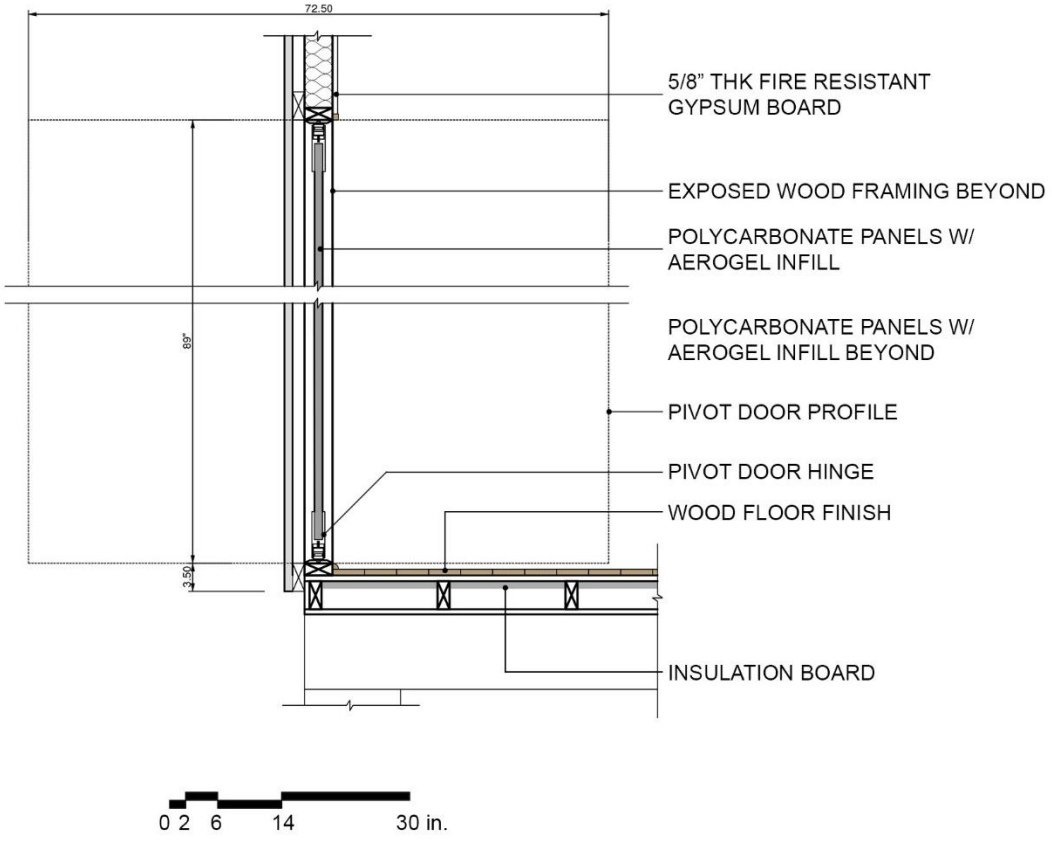
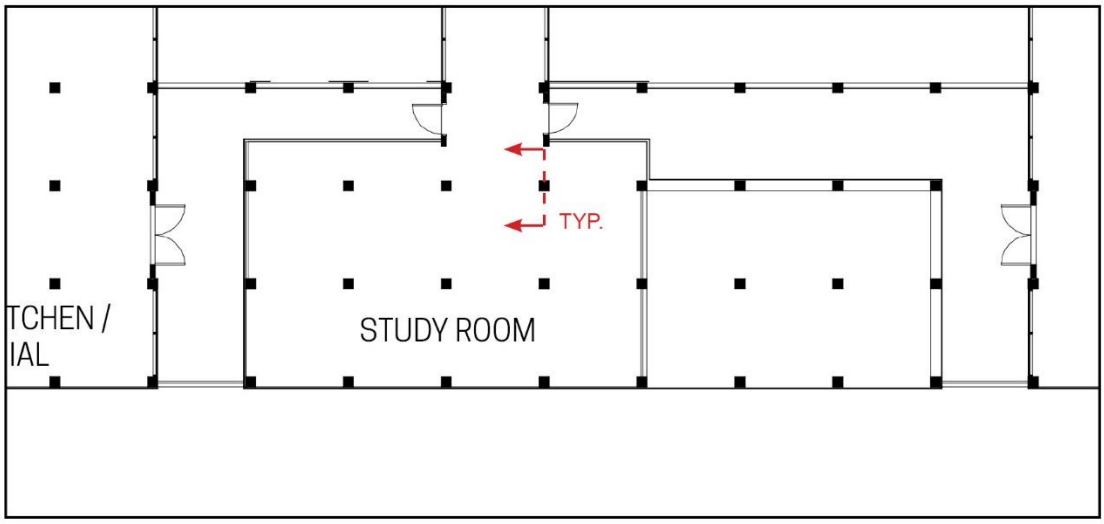


Figure 56. Detail Draft of Polycarbonate Pivotal Doors. Source: Author.



SOLAR GLASS ROOF, STUDY ROOM

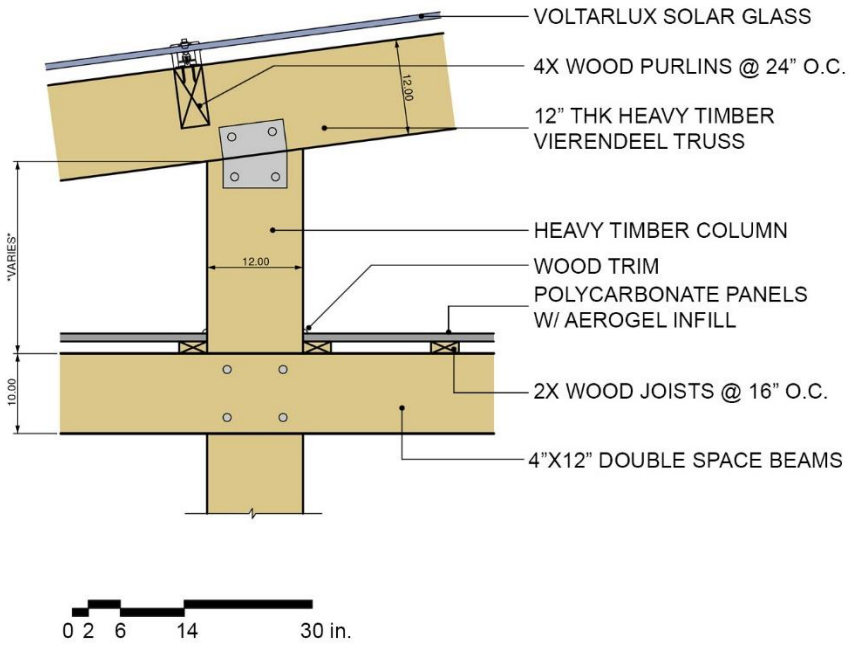


Figure 57. Detail Draft of Solar Glass Roof. Source: Author.

7.3 Physical Model

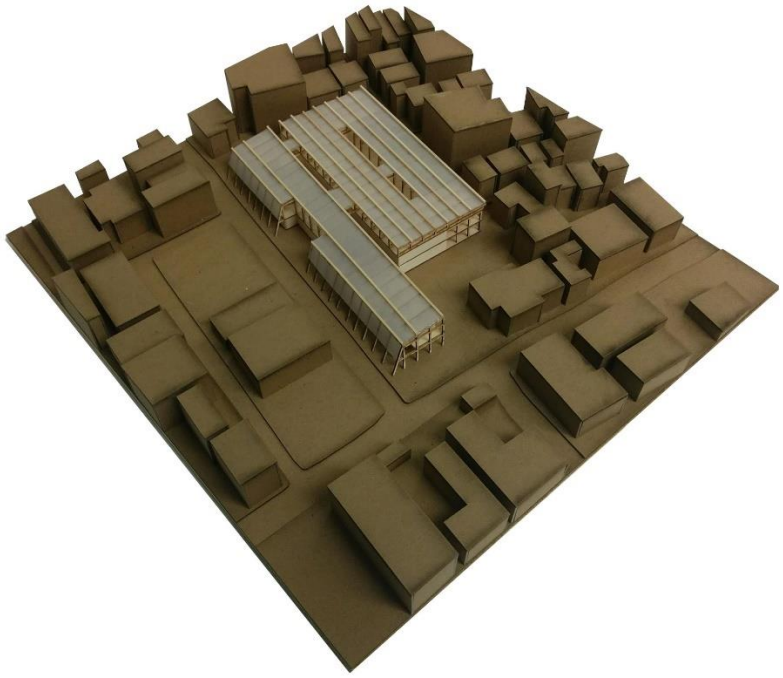


Figure 58. Study Model; Chipboard, Basswood, and Mylar Sheets. Source: Author.

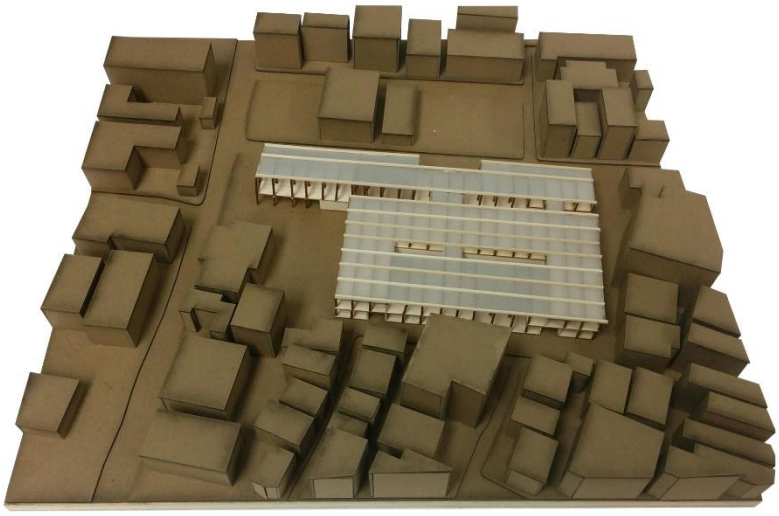


Figure 59. Study Model; Chipboard, Basswood, and Mylar Sheets. Source: Author.

CONCLUSION

As the growing community constructs modern buildings, there are fewer opportunities to build traditional structures. Building lots became more limited which resulted in taller structures to accommodate multiple functions to generate more profit. Unfortunately, we do not have adequate knowledge to utilize traditional building materials such as wood for taller structures. Of course, there are some cases which massive timber construction enabled a multi-story building to be built. However, due to lack of precedents, we were lead to the conventional use of concrete and steel, which disconnects us from our locality.

Particularly in Japan, it has gone through many interventions throughout the history such as the Meiji Restoration and being occupied by the Allied Powers after the World War II. As new elements are introduced in Japan, its community becomes more distant from their culture and identity. So how can Japan maintain its cultural identity? If materiality and building techniques cannot be implemented into modern architecture, then what other aspects could be borrowed to maintain a connection with the past? I hope this research has offered a possibility to future architects that perhaps we can still adopt the community aspect from local villages while moving forward. Regardless of the use of modern construction or building materials, people can still interact in space like how they would have in a vernacular village. The way they use the space can define the cultural identity of the building. Although the modern community has made individuals become more isolated by use of mobile devices

and such, active engagement inspired by local villages can restore social interaction once more.

During my one year of research, I realized that it is important to look back to our origins if we wish to solve issues within a community. For example, my proposal of reimplementing the “sense of village” in the modern residential community may have the potentiality to solve rising Japanese elderly population and need for affordable housing by university students. Furthermore, this unique combination of elderly and student housing might not be feasible in other countries due to sociological and cultural differences. I believe that to solve a community-level problem, it is essential to consider the community aspect of local villages in architectural design. I would like to challenge you to research the communal aspects of local villages in your respective countries and ask yourselves how that could be reimplemented into the modern architecture to resolve community issues.

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