Cooling off Social Meltdown

Hajime Shibuya

SOC

AL

MELT

DOWN

Cover

ABSTRACT

These days many problems are discussed worldwide including the environmental, cultural, and economic fields. Pollutions from industrial exhausts are killing not only the ecological environment but for us, human being. Most of these problems are raised by population growth. We have been covering our physical daily needs by mass production. The environment has been holding such stresses. The solution for this is simply by redistributing the burden of a populated city. Now all the foods and wastes are all collected before and after human use, and this is true for all the other infrastructures. Mass production causes giant risks of damages. Tracing back all the problems that are happening today, it won't take so much to realize that such burdens could be localized everywhere in today's advanced technology. Why do we have to have such a huge power plant that covers all the people in the city, creating frictions in neighboring Environments, while we, individuals are capable of producing them? The trending view in the past that sacrificing the undeveloped area for special needs and special people, created backlashes everywhere on the earth. How could we split them and assign them to solve the issues at a local level?

Fig 1.02

Narrative

context

The Chernobyl disaster happened in 1986. In 2011, an earthquake hit Japan and caused a nuclear power plant accident. We are experiencing large effects of industrial pollutions from these unsolved and never-ending disasters still today. Chemicals that destroyed the environment are well explained in “Silent Spring” by Rachel Carson. Bee’s problems are groan in many discussions. Water purification cannot catch up with new pollution that comes up from every technological advancement. Why do these problems keep happening? Why the solution to these problems is always one step behind and even these solutions seem to create another problem?

In modern economics, population growth is the only way one can thrive and his life to be better off. In this sense, more people lead to more consumption which, therefore, means more room for further expansions. We have been supplemented with powerful and large-scale instruments to cover the demand generated by the vast population. If we keep letting this social structure take the lead in our future, it might seem that it is impossible to tear down existing industrial production lines such as power plants and huge agricultural lands that are responsible for the current materialistic needs of our society.

I believe seeking urban planning revolving around the localization of lifeline production and treatment of waste material will bring us truly sustainable lifestyles to many of the cities today by shifting the current social and economical structure, and fit it to the change that is happening already with the ongoing pandemic of Corona Virus.

PREMISE

Redistribution of concentrated current loads in manufactory, requires the ability to produce the goods and resources in local areas. Each of individual units or housing should take small parts of the burden that mass production facilities are responsible for. For example, farmers are taking all the risks for providing basic needs for food consumptions of a nation. The reason why we have to keep killing bees and ruining the soils by utilizing chemicals, is because there is not enough hand and place to maintain the level of production up to the demand of people in the rest of the area or the country. This is true for all the other infrastructure. We depend on powerplant, and sewer, and mass transportation to support our survival and often to the extent of unnecessary luxurious living.

It has been thought that having role is good and beneficial to provide specialized service for the entire community. But this notion became too big in scale. In modern society, skyscrapers are built up to occupy workers who is commuting to their jobs and these workers return to home from their office when they are done with their work while mass productive institutions in rural areas are supporting such busy life in big cities. This polarization of our place; one for work; and the other for manufacturing has caused unhealthy problems.

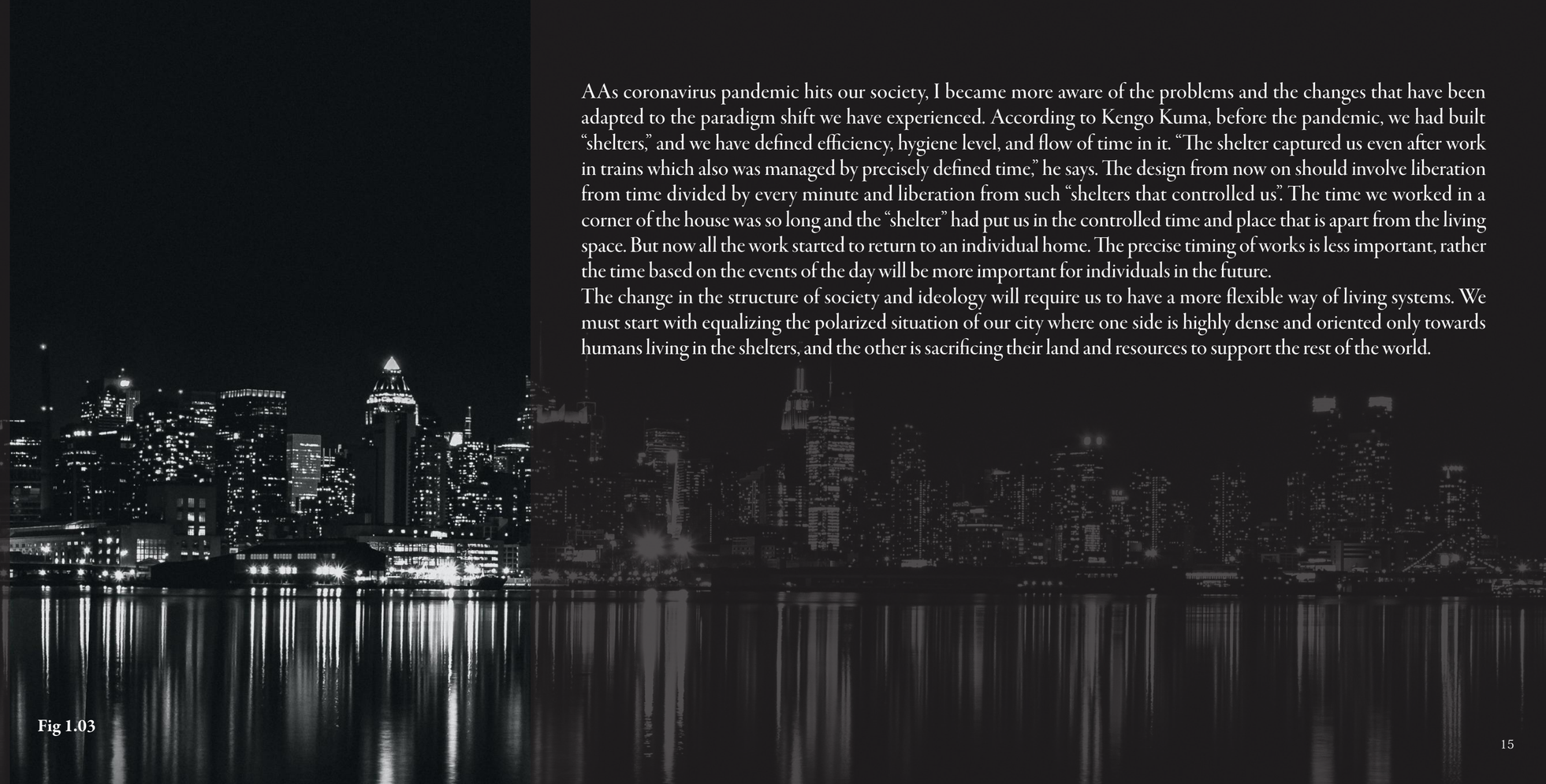


Fig 1.03

AAs coronavirus pandemic hits our society, I became more aware of the problems and the changes that have been adapted to the paradigm shift we have experienced. According to Kengo Kuma, before the pandemic, we had built "shelters," and we have defined efficiency, hygiene level, and flow of time in it. "The shelter captured us even after work in trains which also was managed by precisely defined time," he says. The design from now on should involve liberation from time divided by every minute and liberation from such "shelters that controlled us". The time we worked in a corner of the house was so long and the "shelter" had put us in the controlled time and place that is apart from the living space. But now all the work started to return to an individual home. The precise timing of works is less important, rather the time based on the events of the day will be more important for individuals in the future.

The change in the structure of society and ideology will require us to have a more flexible way of living systems. We must start with equalizing the polarized situation of our city where one side is highly dense and oriented only towards humans living in the shelters, and the other is sacrificing their land and resources to support the rest of the world.

Project Typology

The main goals of this project are essential to break the current typology that sits on top of the economical foundation. Through this project, it intends to eliminate the typology, especially, hotels and apartments. However, to be more practical, the typology for my project will fall somewhere in between these two.

The success of this project will establish the base for people to live with flexibility. We are constrained by physical location and financial situations. The problems of gentrifications are mainly caused by the polarized economic climate. But the project intends to get rid of these notions.

To be more specific, the plan will blend the space for food productions and workplace, processing of water and waste, and energy generation. If this could happen in every local area, locations start not to matter anymore since one can have any kinds of job working from home and have access to any quality of foods, and the same level of convenience.

This will get rid of the idea of rent or hotel costs, and some of the transportation costs.

Fig 1.04

Major Project Elements

Fig 1.05

GREENHOUSE

The greenhouse will serve two roles. One is to employ a passive system, and the other is to utilize the space to have more greenery space and to raise actual plants. These plants will be put based on the idea of hydroponic cultivation and phytoremediation to utilize gray water that is generated from everyday life.

APARTMENT UNITS

This will be the center of living for habitants. Output from this place is gray water, garbage, and air.

GYM

People use electricity to work out, conversely, muscle power could be used for generating electricity instead. We could incorporate the electricity-generating devices into work-out equipment. Electricity will be distributed and used by the habitant in the community.

COMPOSTER

Collect food waste and turn them into fertilizers by germs and enzymes. This will take place in each residential unit, and the resident could either use it in the garden or sell it to possible buyers.

SOLAR POWER PANELS

The panels will help to generate electricity in the building.

SEWER AND FILTER

This element collects rains and utilizes it for water supply in the garden or human use.

User Description

Fig 1.06

MANAGER
They will be responsible for supervising each unit in the apartment.

RESIDENTS
Residents are the one who will mainly be the one using the system.

ELECTRIC/ENERY FIRM
Possible buyer of excessive electricity

MAINTENANCE STAFF
In the case of special occasion.

COLLEGE STUDENTS
I would like to incorporate college student of local area and the program of this project in order to introduce the possibility of self-sustaining living, and also to help them to open up the view for their future.

Project Goals

The main goal of this project is to complete the cycle of resources within the community of its own. There will be so many outputs generated from our human living habits. I would like to turn such output into input for another resource. As I mentioned above, for example, greywater is something we cannot stop generating and this will continue to flow away if we let it go. The room for another use will be completely wasted. Gray water has a certain hygiene level, and this is still well controlled in a drainage pipe. The challenge will be to figure out how much pollution from soap or plastics or other kinds of substances in water can be taken for plants to grow. The idea is the same for the gym and other components of the program of this project.

All these attempts and plans are to exit from economic constraints and ultimately from the transportation system that we depend on. The success of the project will bring us not only to be able to spend flexible life in such systems but also allow us to stand in the disastrous situation due to independence from transportation and mass production system.

Fig 1.07

Research

RESEARCH DIRECTION

Researches must be done in self-sustaining practices that have been done in the past and the ongoing projects. The self-sustaining aspects include basic human needs such as electricity, HVAC system, food, and reuse of waste materials. These will be applied to a residential building or its community. Each unit in the building is responsible for running and maintaining the circle. To create such a system and community along with the environment will require a study on smart application techniques that is necessary for producing and recycling the basic human needs that I have mentioned above. The techniques will involve gardens in small units, composter, passive heating, and cooling system, even community building is part of the key for this project to be successful.

Fig 2.01

DESIGN METHODOLOGY

Graphic Analysis must be employed in passive system research since there is a different context for each climate of the site. The incorporated system will be better explained in a diagram to show the method utilized. The material testing and experiment with the waste material process will require quantitative/qualitative analysis.

DOCUMENTATION

All material experiments should be documented as a series of pictures with a timeline included. Documentation must be recorded every time the testing process progresses further into new steps or shows new results. This will show the workflow of the experiment procedure and can present the feasibility of the testing material and its use. Thus, it will be included in a book form under the material experiment section with research that is previously done.

Works from the research will be compiled in a thesis research section. They will be organized and kept in PDF files. This will also be included in the book but will be presented on a board as well, as needed. This research part will mainly show each component of buildings. Therefore, all documentation mentioned earlier will be presented such that the viewer can see the entire picture and at the same time, will be able to focus on details presented in each component.

Case Study

Yin & Yang House

Architect

Penda

The project type

Residential

Location

Kassel, Germany

Program

Office

Kid's Room

Bedroom

Kitchen & Dining Area

Rooftop with a Garden

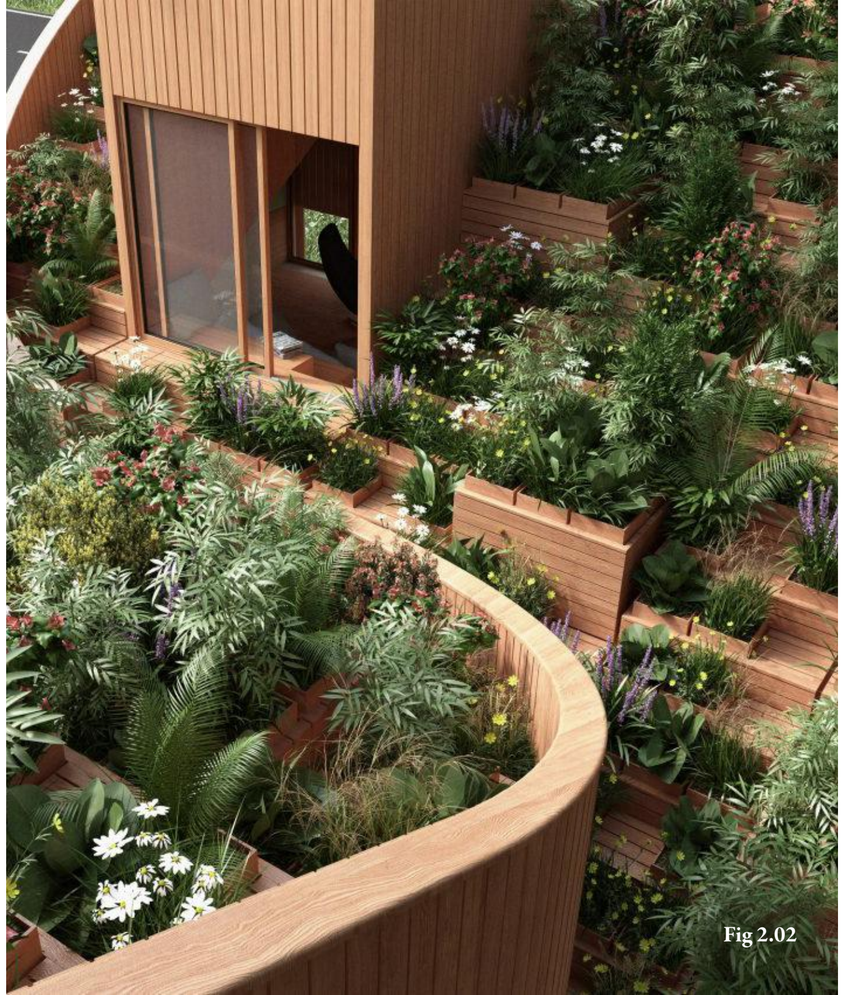


Fig 2.02

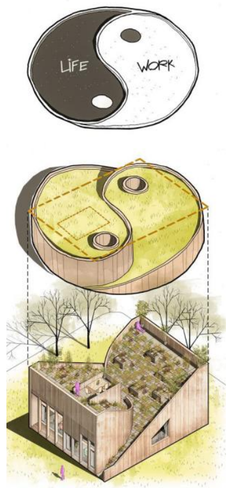


Fig 2.03

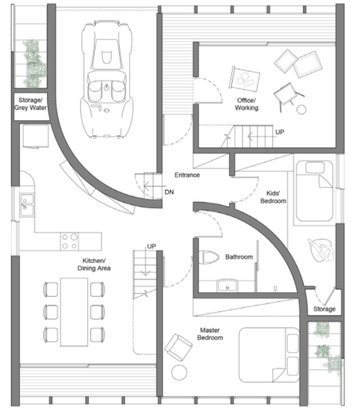
The concept of "Yin-Yang"

The concept of "Yin-Yang"
The design of the house is based on the concept of “Yin-Yang.” The dualistic idea constitutes of sun and moon, plus and minus, light and dark. The dichotomic separation is applied to the composition of the spacing in the house as well; one is work where offices are, and the other is life includes dining and living room.

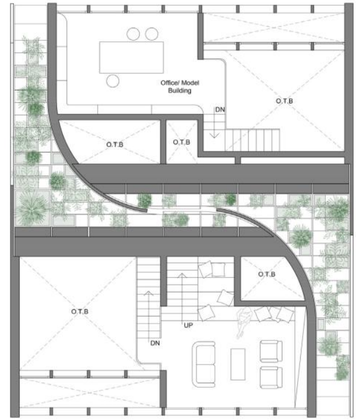
Floor Plan Composition and Circulation

The iconic diagram of “Yin-Yang” dissects the house with curvy which will bring natural flow to the life of the residents. This hospital flow promotes coming visitors to arrive in the center of the house. The workspace including offices in the house is positioned in the north side which will get constant rhythm and lighting for working environment. Whereas the south side is mainly consisting of spaces for the resident’s personal life such as bedrooms and living room.

First Floor →
Fig 2.04



Yin & Yang House Floor 1



← Second Floor
Fig 2.05

Fig 2.06

Fig 2.07

Fig 2.08

Conclusion

This case study shows that the coexistence of human life and food production in the size of a normal residential housing is possible throughout even the harsh season in Germany. Germany's winter average temperature is 3 degrees Celsius and sometimes reaches -10 degrees Celsius which is quite harsh for some of the plant species. The designer of "Yin & Yang house manages to be able to keep the plants in winter as well by having small greenhouse spaces on the roof.

Fig 2.09

Fig 2.10

Regen Village

Designer/Founder

James Ehrlich

The project type

Infrastructure planning

Strategic planning

Location

Almere, Netherland

Program

Animal Hold

Activity Area

Bonfire Place

Apple Yard

Community House

Seasonal Gardens

Bike Pit

Electric Carshare

Residential

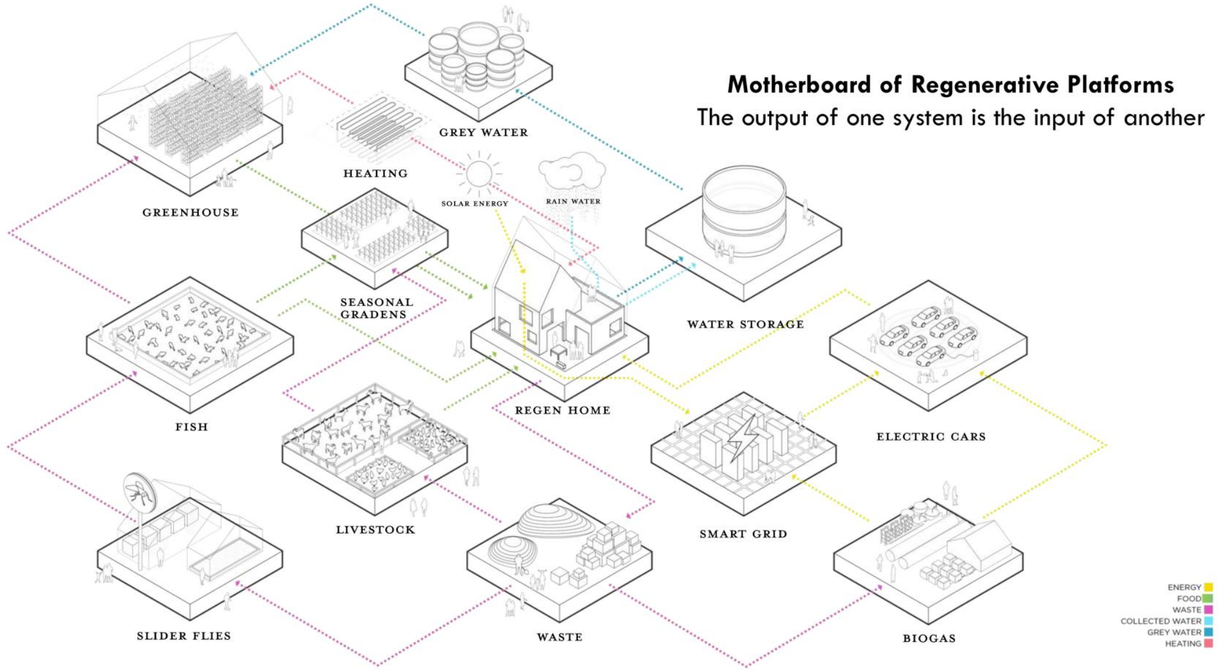


Fig 2.11

Phase I-IP

ReGen Villages PHASE I IP is based on the closed-loop organic food and small animal waste digestion platforms, with proven research and development of increased breeding and harvesting of bio-generators at the neighborhood scale

Phase II-IP

ReGen Villages PHASE II IP is based on machine learning and autonomous improvement algorithms of shared system platforms based in part on internal village data and then subsequently on cloud-connected villages around the world in similar climate zones. Developed in cooperation with Stanford Foresight Innovation Lab on the Microsoft Azure cloud platform.

Phase III-IP

ReGen Villages PHASE III IP will focus on robotic actuation via mechatronic devices triggered by sensor inputs embedded at the substrate of village shared platforms, as the mechanism for mitigating risk in highly variable systems, moreover improving thriving outcomes for improved yields.

Fig 2.12

Building regenerative off-grid communities that produce more organic food, clean water, renewable energy, and mitigated waste at the neighborhood scale

Aquaponic Ecosystem Integration

This part of the eco cycle system has several species of freshwater fish, shrimp, and crawfish. Fish waste will be fed to the agricultural cycle as fertilizer for the soil-free grow beds which raise the edible vegetation for community needs.

Vertical Growing System

The greenhouse is capable of over 9 harvests with fewer labors and efficient LED lighting, geothermal heating and cooling, vertical farming. This will provide 110,000 pounds of food per hectare per year. “In combination with seasonal gardens, food forests and permaculture practices it is estimated that 100 families could supplement their nutritional inputs by 60% in developed countries.”

Thermal Batteries

Regen community utilizes a Thermal Battery System which combines solar thermal collectors, a water source heat pump, and a latent-capable Thermal Battery. This system is capable of efficient heat and cool buildings. “Poly cistern tank with an internal heat exchanger is filled with phase change material of water. This tank is buried in the earth outside a home and readily collects and stores energy that has been integrated with the system.”

Geothermal bore holes

Circulating water between the house and the earth, will provide consistent heating and cooling for house units with low energy. The water circulates through closed plastic pipes that are buried in the ground. These loops of pipes will be buried below the frost point where the temperature is kept between 40°to to 80°C depending on where the house is located.

Fig 2.13

Skyfarm

Designer/Founder

Aprilli Design Studio

The project type

Urban Design

Net zero

Location

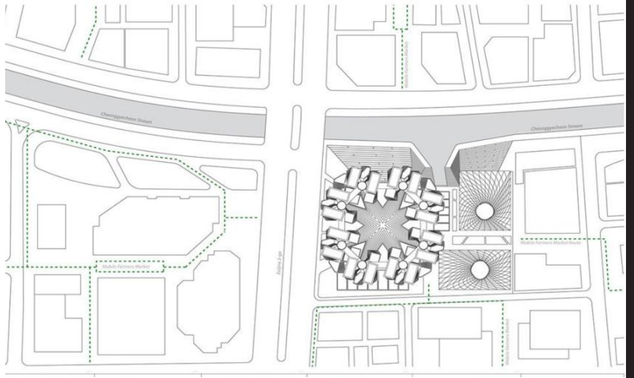
Seoul, South Korea

Program

Vertical Farming

Water Process System

Fig 2.14



Skyfarm is designed for improving environmental quality in the urban area. It produces green areas, renewable energy, and filtered air and water. The reduced head accumulation, stormwater runoff, and carbon dioxide will be provided to the dense urban area. The plantation will create oxygen continuously converting carbon dioxide. The water processing systems involve rainwater collection, water filtration, water treatment, and it is distributed to the planter floor of the building and/or redistributed to the city.

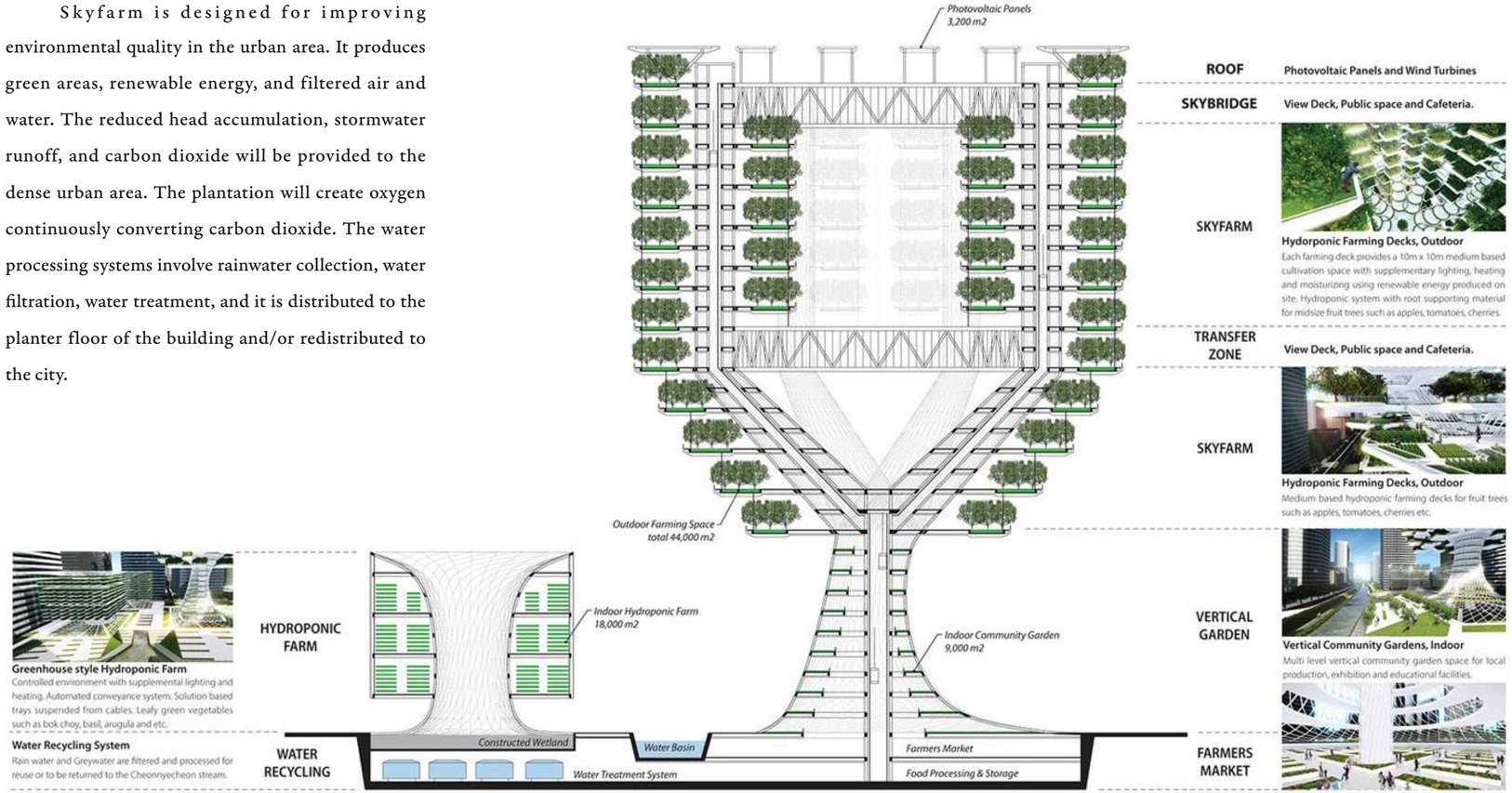


Fig 2.15

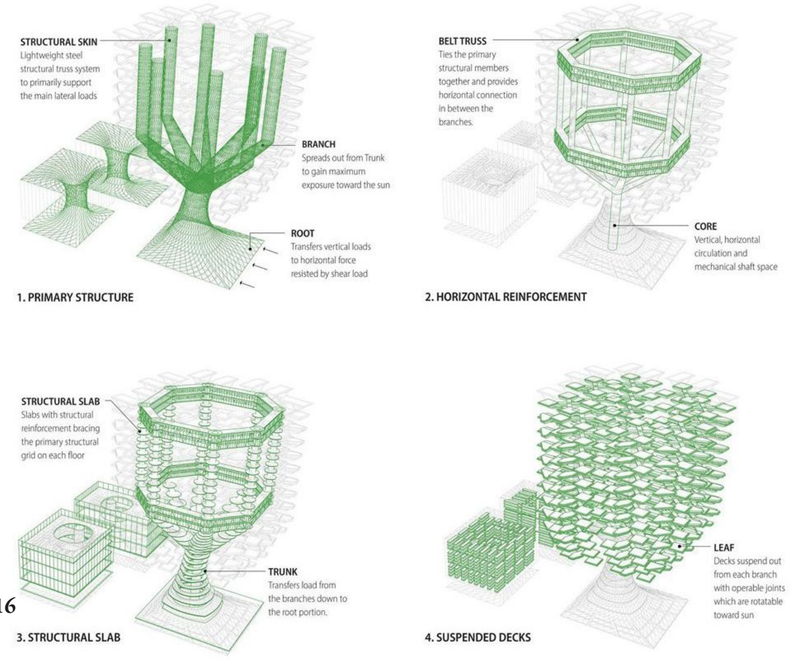


Fig 2.16

The base of the structure is called the root portion which provides space for the market, public activities. The trunk is the part of the building that supports the upper portion and transfers the loads to the ground. This area has a great outside view and is ideal for a community garden. Eight of the structural skin derives from the trunk. Each contains the space for 60 to 70 farming decks which are suspended by lightweight trusses and tension cables. This farming area is called the leaf portion which is designed to get maximum sunlight exposure.

Having sunlight as the main resource, vertical farming utilizes hydroponic systems with the conditioning of lighting and heating, and moisturizing. Vertical gardens are lifted in the air to get maximum exposure to sunlight. This area is called the leaf portion and occupies plants such as trees which need more exposure. In the lower area, farming is mainly solution-based indoor cultivation utilizing artificial lighting.

Fig 2.17

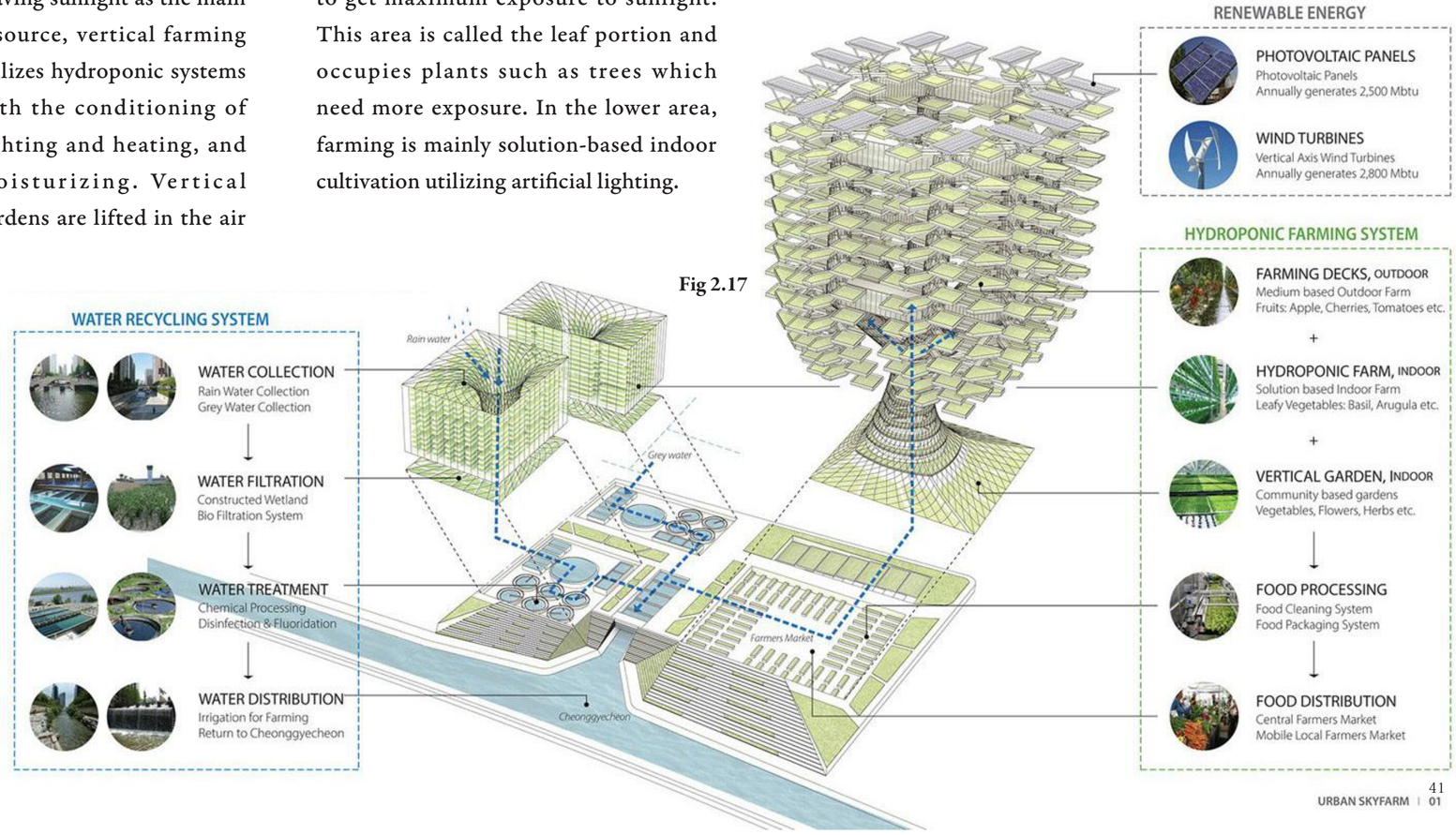


Fig 3.01

Literature Review

SCALE

E.F. Schumacher

The role of economics

Todays concept of economics and its market focuses on demand and supply balances. Prices doesn't reflect what they really are. Buyers are often bargain hunter and not concerning the origin of goods. This structure of the market will assess only surface of manufacturing goods. In other words, economics today neglects the distinction between various goods in the market.

What we call "the goods" are essentially conversion of things or services from one to another. Therefore, there has to be an original source to be converted which is called "primary goods." It has two categories; non-renewable and renewable. We have "secondary goods" as a means of providing "the primary goods" for public. Manufactures and Services belongs to this category. The goods from different categories have totally different values, however, the goods are equally treated in the market. $50 of oils and $50 of wheat and $50of Shoes, and $50 of hotel reservations are all has the same value when it is weighed in economical scale.

Buddhist Economics

In modern Economics labors are viewed as a necessary evil. For employers, the maximum benefit will be brought if they can extract outcomes without hiring labors. For labors, getting paid without doing anything is the ideal situation. 'If the ideal with regard to work is to get rid of it, every method that reduces "the workload" is a good thing.' Time is broken down to every minute so that even fragment of time is not going to be wasted and the manufacturer will be able to achieve goals without having anyone processing workloads with slow speed.

"The Buddhist point of view takes the function of work to be at least threefold: to give a man a chance to utilize and develop his faculties; to enable him to overcome his ego-centeredness by joining with other people in a common task; and to bring forth the foods and services needed for a becoming existence."

In Buddhist view there are two concepts that forms automation. One is that enhances the human skill and ability. Second is that there is a part where turning the man's work to mechanical slaves. In the book Paul Hawken explained it using an example of a carpet loom. The carpet loom is the tools, and dealing with the warp thread is man's skill, and the time sitting in front of the loom is the sacrifice to turn the labor work to a mechanical slave.

If this nature of work is applied, it nourishes and urges a man to the best he is capable of. In this sense, losing a man's job will put him in desperate position, not just because he will lose the source of his income but because he will lack the enlivening factor of disciplined work which is irreplaceable.

Buddhist views the notion that consumption leads to wealth, as irrational since consumption is merely a means to be well-off. If the goal of making cloth was to keep the temperature at comfortable level and have attractive appearances then, Buddhists seek for the way to obtain it with minimum effort possible.
In modern economics the more the consumptions the person affords, the more better-off he is. This society pursue more consumptions of goods as its ending goal.

As physical resources are everywhere limited, people satisfying their need by means of a modest use of resources are obviously less likely to be at each other's throats than people depending upon a high rate of use. Equally, people who live in highly self-sufficient local communities are less likely to get involved in large-scale violence than people whose existence depends on worldwide systems of that.
Therefore, from the point of view of Buddhist economics, therefore, production from local resources for local needs is the most rational way of economic. Export and import are only justifiable with exceptional cases.

Modern economics does not distinguish between

renewable and non-renewable materials, as its very method is to equalize and quantify everything by means of a money price. Thus, talking various alternative fuel, like coal, oil, wood, or water-power: the only differences between them recognized by modern economics is relative cost per equivalent unit. The cheapest is automatically the one to be preferred, as to do otherwise would be irrational and "uneconomic."

Questions of Size

We need both freedom and orderliness. We need free will at smaller scale since essentially our action is driven by individuals. There is a limit for numbers of people a man can get in touch with, in a certain time frame. Orderliness or rules must be utilized at large scales. There is also a limit for such activities originated from personal actions. Thus, relationships often could only be established in certain group people at the scale of free will. That is why we need orders to deal with those cracks between human groups so we all can be "brother" and cope each other.

There is always significance in duality of the human requirement especially in question of scale. "There is no single answer." Human needs different types of structure depending on each purpose; both smalls and large, exclusive and comprehensive. There is appropriate size for every activity, and it can be determined by assertion. There are some that can be done within small groups, and others may be done in large scale for example via network system. The concept of giantism however, could cause people to be footless due to the availability of modern technology. Before such advent of technology people were immobile and structure was there to balance the society, but mass transportation and mass communication made the structure less vital, therefore made the country less organized and stable.

WATER

Sabino, D. G., Patrizia Casella
Michele Notarnicola
Roberto Farina

Grey water in buildings: a mini-review of guidelines, technologies and case studies

Abstract

Grey water is defined as wastewater without an input from toilets and so includes sources from baths, shower, hand basins, washing machines, dishwashers, and kitchen sinks. These different level of pollution by human use was combined in one pipeline and brought to sewer system and treated jointly as single kind of water, black water. However, with the technological advancement and paradigm shift due to the advent of environmental issues and more focuses on reuse of limited resources, the water waste begins to be regarded to be used again as resources. Most common use of greywater is toilet flushing which could reduce the water use of housing up to 30%. More use wastewater is considered for many other applications such as irrigation and, car washing, and preservation of wetland. Each application requires certain level of cleanliness, and varies depending on the use, but usually defined by organic, and microbiological content of the water.

Grey water Characteristics and amounts produced

Generally, types of grey water are defined by where it's drawn from. The categories consist of 5 different origins and the use which are bathroom, laundry, kitchen dishwasher, and mixed. A parameter is set for different criteria such as the quality and type of the water supply, the activities in the household, installation from which grey water is drawn, geographical location as well as demographics and level of occupancy.

Kitchen grey water has a high biological characteristic which is called biochemical oxygen demand (BOD), because it contains food particles, oils, and cleaning agents. Laundry grey water has high amount of nitrogen, sodium, phosphate, baron, surfactants, ammonia from soap powders and soiled cloth, and therefore it possesses high BOD. Whereas bathroom grey water contains soap, shampoo, hair dyes, suspended solids, hair, and turbidity, thus has lower level of BOD. In sum, the analysis suggests that the kitchen and laundry grey water contains high organics and physical pollutants than the bathroom and the mixed grey water.

Powdered laundry detergents are the most outstanding pollutants of greywater which contains high salt concentration, and often still has phosphorous and are strongly alkaline. Reuse of this type of water that contains high salt concentration for plants will cause possible damages to plants due to salt accumulations in the soil and could harm those plants with low phosphorous tolerance.

Treatment systems and reuse technologies

Water treatment go through first by a solid-liquid separation step as pre-treatment, and post-treatment of disinfection steps follows the first process. Septic tank, filter bags, screen, and filters are applied to reduce the number of particles, oil and grease in order to avoid clogging, whereas disinfection process is applied to meet the microbiological requirements.

The combined solutions which utilizes aerobic biological processes and physical filtration and/ or disinfection are considered to be the most economical and feasible way for treatment of grey water today. Even though it requires huge scale of space, constructed wetlands are thought to be the most environmentally friendly and cost-effective in terms of treatment performance and operational and management costs. In contrast, biological treatment involving the RBC (rotating biological contractor) is more suitable with certain building dimension.

It is said that the MBR (membrane bio reactor) is the only method to remove organic substances, surfactants, and microbial contaminations without a filtration and disinfection step. It is considered to be the ideal technical solution for grey water recycling, especially, in urban residential buildings.

Since there are numerous variations in the use and treatment options, one must understand how the grey water will be used and in what necessary level of treatment is required for

the use. Often one method of treatment alone wouldn't satisfy the requirement for reuse. For example, grey water needs to be well filtered and disinfected for flushing toilet and surface irrigation. Different color usage for piping system and dying water is implemented to avoid confusion between types of water at different stages of treatment and its purposes.

Overview of case studies

There are several case studies listed in this section. The first case is Klosterenga, an apartment with 35 residential units, and located in Oslo, Norway.

Klosterenga contains well designed energy- and water-conserving features that can reduce energy and water use. Using a high thermal mas and a combination active/passive solar system, Klostrenga consume less energy comparing to the same size of residential apartment. It also utilizes on-site grey water treatment, radiant flooring, and water-conserving fixtures.

The water conservation system in this building includes a water-conserving indoor fixtures, an on-site grey water treatment system, a rainwater collection, and a partial green roof. Each unit is equipped with low-flow faucets and showerheads, and other installments for lesser water consumptions. The first year of water use was about 45,500L/person according to the water metering.

A dual waste-pipe line system is installed in this building to separate toilet waste and greywater. Toilet waste is directly sent to municipal sewage system whereas greywater is pumped to the greywater filtration system in the courtyard. In the garden, rainwater is collected and redistributed for garden where it also serves as a playground.

The second case study is on Preganziol, Northern Italy built between 2004 to 2005. This project utilized two constructed wetland systems for population of 240 people. Water runs always below the reed bed that is filled with fine gravel, planted with phragmitesaustralis. This prevents leak of odors and health risks while having consistent access to them. After treatments the grey water is collected and redistributed to each unit for toilet flushing, while rainwater will go through a vertical-flow-constructed wetland system and then collected with grey water for use in irrigation.

Energy implications of grey water reuse technologies in the planning stages

There are so many cities where water treatment and recycling plan is implemented and attempting to redesign the whole city. In the huge planning stages careful analysis and evaluation has to be done especially in use of decentralized on-site wastewater systems. The author used the city of Melbourne in Australia as an example to show the use of grey water recovery system is possible options for us.

In terms of energy consumptions of various kind of grey water recovery system, there are many factors to be considered to judge if the installation of one system would increase or decrease the efficiency and amount of energy to be spent to run. Generally, there are three factors for considerations which are following; firstly, the energy intensity of the current water supply and wastewater treatment, and secondly future infrastructure needs, and finally the energy intensity of the grey water system.

Use of highly energy intensive which may include water through desalination or long distanced pumping, will decrease energy requirements. In contrast, use of non-energy intensive cycle in local water sources, grey water recycling may increase the energy requirement of the household.

PRODUCTION

Redmond Ramin Shamshiri
Kalantari Kalantari Fatemeh
Ting K.C
Kelly R Thorp
Ibrahim A Hameed
Cornelia Weltzien
Desa Ahmad
Zahra Mojgan Shad

Advances in greenhouse automation and controlled environment agriculture: a transition to plant factories and urban agriculture

Abstract

Historically, the greenhouse started with simple covered rows of open-fields crops. Technological advancement allowed it to grow to be a highly sophisticated controlled environmental agriculture (CEA).

There are several factors to be considered for designing viable greenhouse system for producing year-round crops such as landscape, topography, soil, climate conditions, microclimate control system, light condition, intercepted solar radiation, windbreaks, the availability of electricity, roadways, and labor force. In addition, the environment, economic and social factors must be in consideration for large-scale commercial greenhouse production.

Covering Materials

Covering materials have several aspects to be considered which are supporting foundation, shape and framing materials, geographical direction for optimal light entrance, the load of equipment, factors for static and dynamic loads, dimension ratio and volume. Covering materials could varies depending on the situations.

The most dominant transparent materials are;
2-3 mm glass panels, net-screen film
0.1mm and 0.2 mm Polyethylene (PE)
0.2 plastic films, and ultraviolet (UV)
0.3 stabilized PE-films.

Glazing materials in greenhouse let shorter-wavelength radiation to pass through but long wavelength radiation (infrared) to hold inside. These list of materials are used for different spectral frequencies. Some of them are designed for capturing the heat energy inside.

The airflow rate should be 0.04-0.05 m3 /s of floor area (1 m^2) for a reasonable heat rise of less than 4°C in a glass-clad greenhouse. The material variation is subjected to climatic situation as well.

one layer plastic
double-wall plastic
glass
fiberglass
double-wall plastic
acrylic sheet
polyethylene film
polyvinyl chloride (PVC)
copolymers
Polycarbonate panels
selective transmission medium
(Further detail by a study on the effects of cover diffusive properties on the components of greenhouse solar radiation)

Hemming and Jarquín-Enríquez mentioned that the biosynthesis in tomato fruits was increased in the early growth in their study on relation between double layer plastic and flat glass cover and lycopene accumulation.
Polythene-clad greenhouse does not get as hot due to the transparency of the plastic to long-wave radiation. Hence, this type of green house doesn't require huge ventilation rate and could be reduced to 0.03-0.04 m^3/s of floor area. This restricted amount of solar radiation will create a different air temperature between inside and outside which is important in tropical climatic zone where inside of polyethylene film covered greenhouse without environment control, can gets 68 to 70 degree Celsius while outside temperature is 28 to 33 degree Celsius.

Light control and artificial lights

LED has research and development community because of its advantages such as cost efficiency, compact design, durability, light quality, and low thermal energy generation. These factors allowed vertical CEA of plant production, while keeping the cooling lards low due to its efficiency of energy transformation

into light. Color shaded light is helpful in how weathers filtering specific wavelength the plants need, and yet it is not effective in cold and shady climate where pants needs rather as much light as possible.
Choosing right plant density is important to get an optimal crop water and light capture. On the other hand, the planting density affects harvest of crops such as tomatoes. Several studies show that the number of flouring and weight of fruits were all lesser.

Urban agriculture (UA) and Vertical Farming (VF)

The integration of VF with architecture is established first by Gilbert Ellis Bailey where he employed the concept of tall multi-story buildings for indoor cultivation. Designers and landscape architects have looked at the concept frequently in late 20th centuries. In 1970s to 1980s Malaysian-born architect, Ken Yeang took the idea and improved it into architectural project called Bioclimatic Skyscraper which was built in 1992. In 1999, Dickson Despommier at the Columbia University calculated that 30 floor of farming area in one city block could provide food for 50,000 people with vegetables, fruit, eggs and meat. Dickson adds that hydroponic crops are suited in upper floor whereas in lower floor it is optimal for livestock rising such as chickens and fish that eats plants waste. Recyclable sources of energy that could be considered for VF to run is geothermal, tidal, solar which could provide heating and lighting needed for plants growth.

There are many publications and researches showing that VF is promising techniques to provide food for cities. Discussions often fall into whether the return is worth enough for structuring costs, and some says that abandoned building can be used for VF area. Urban Sky-farm in Seoul is an example that shows the feasibility of VF practice in urban settings. This design was the winner of the 2013 green dot design competition. The purpose of having VF is to maximize the crop yields under optimal circumstances even in the center of the city. For this reasons, Urban Sky-farm is capable raising variety of produces in multiple floors. In any cases, the design and location of VF is the key factor to achieve efficient and maximum corps. Hence, keeping track of kind of crops and its location is significant for increasing the feasibility of VF in urban setting.

Another way for UA is the rooftop greenhouse (RTG) and integrated rooftop greenhouse (i-RTG). The basic concept of these are constructing a greenhouse for soil-less agriculture on top of roofs. Advantages of RTG and i-RTG are confirmed by Pons and Sany o-Merngual, and parameters are listed for example, the greenhouse and building, global advantages, local advantages, integrations and adaptations with the building, as well as production benefits.

Some researches show that i-RTG are not successful providing light diffusion for plants which leads to low radiation use efficiency (RUE). However, i-RTG has better and uniform temperature regime and the thermal links to the building which results significant energy saving in comparison to the traditional ground based greenhouse.

RECOVERY

Robin Harder
Rosanne Wielemaker
Tove A Larsen
Grietje Zeeman
Gunilla Öberg

Recycling nutrients contained in human excreta to agriculture: Pathways, processes, and products.

Mixing of human excreta with other streams

Human excreta often are mixed with other streams. Collected urine may involve flush water and may be called source separated urine or yellowwater. Human feces involve with urine, flush water, anal cleansing water, toilet paper, and additives such as ash, lime, or dried soil. It is usually called source-separated feces, brownwater, excreta, or blackwater. In conventional urban sewage pipeline, human excreta usually mixed with flush water, anal cleansing water, toilet paper, domestic used water, industrial used water, and possibly even stormwater.

Sources of carbon, nutrients, and contaminants in mixed streams

Flush water contains heavy metals and organic pollutants originating from the water supply system, as for example copper (Cu) and lead (Pb) can be released from metal pipes or organic compounds from polymeric pipes. Later, it will be added with water from households, hospitals, industry, and the commercial sector, and with stormwater where it is also discharged to the same sewer. Pathogens mainly originate from human excreta and meat preparation in domestic kitchens or commercial processing of animal products.

Recovery pathways

Treatment starting from blackwater begins with biological treatment followed by liquid-solid separation. Biological treatment can involve precipitation or granulation which allows simultaneous nutrient extraction. The solid fraction, or the dryer primary inputs feces and excreta could be added to help depollution or biological decomposition or thermal decomposition of organic matter.

Treatment starting from sewage commonly engages liquid-solid separation preceded by or as a part of biological treatment. The liquid fraction or effluent can be aided for contaminant reduction or nutrient extraction. The solid fraction can be aided for the same processes in addition to biological or thermal decomposition of organic matter.

There are some cases that thermal decomposition processes are aimed for retaining carbon in the form of energy carriers instead of nutrient recovery. Such process involves hydrothermal carbonization, hydrothermal gasification, and gasification

Biological treatment

The activated sludge process was invented to remove organic matter form municipal sewage and industrial wastewaters. Later, biological N and biological or chemical P removal processes was added to overall process to reduce the emitted N and P. The upflow anaerobic sludge blanket reactor was developed. Blackwater is effectively cured with the technology.

Anaerobic digestion enables recovery of energy in the form of biogas and nutrients in the form of digestate. Through the process of biological decomposition, nutrients are extracted form organic matter. When biological treatment happens in open system, volatile from of N will be discharged to the air and soluble nutrients remain in the liquid. Biological decomposition can inactivate some pathogens decomposing some organic pollutants.

The carrying volatile components form liquid to a gas stream is called stripping and has long been known to be useful to remove ammonia from urine or ammonia-rich wastewater. Ammonia discharge form a liquid to a gas stream can also happen as side-effect of water extraction process. Pathogens, organic pollutants, and heavy metals still can be assumed to remain in the stream from which ammonia has been released.

Pathogen inactivation

Pathogen inactivation and removal make sure the stream is at safe hygiene level for fertilizer product. Some of the separation process have aimed to separate desired products form those not desired. The inactivation of pathogens of degradation of organic pollutants can be achieved through storage, thermal storage, and pasteurization which focus on pathogen

inactivation in liquid streams.

Solutions derived from human excreta contains much of nutrient but lacks in suspended organic matter. When it is used as fertilizer the nutrient solutions are quickly released and ready to be absorbed by plants right away. Generally, nutrient in fertilizer are categorized in two types of nutrient which are multinutrient and macronutrient solutions. The multinutrient contains both macro- and micronutrients. Whereas macronutrient solutions contain one or several of the macronutrients NPK but no or only traces of micronutrients.

Precipitates

Precipitates are employed for wide range of treatment both target and non-target. This treatment has two categories which are multimineral and monomineral precipitates. Multimineral precipitate refers to precipitates that contain a range of different minerals. The term monomineral precipitate means that only contain one mineral, or at least where only one mineral is the target mineral.

Ashes and slags

Ashes and slags are generated by thermal decomposition of organic matter. Pathogens organic pollutants are not included in ashes and slags, but main concerns are the heavy metals. Process that separates P from heavy metals of ashes and slags are still under development. Mostly ashes and slags are not suited for agricultural use. However, thermochemical ash treatment could potentially provide P for direct agricultural use.

Sorbent

Various kind of sorbents are investigated to that macronutrients NPK from liquid streams. Salinity potentially present in the feed solution can be reduced by sorbent due to the higher affinity that targeted for desired nutrient cations.
Extensive studies on sorbent largely remain silent about potential sorption of micropollutants and heavy metals along with nutrients, as well as desorption characteristics of these contaminants.

Patterns and trends

Historically, agricultural use of human excreta was major way to reuse nutrients in human excreta and wastewater. In 1970s, nutrient extraction started to support the recycling processes. The early examples of such attempts include extraction through precipitation, algae growth, or sorption and extraction of phosphorus from sewage sludge ash. From mid 2000s the effort was increasingly made towards nutrient extraction which includes extraction of nutrients from liquid streams and wet organic matter through precipitation, sorption, membrane processes, or phototrophic biomass growth; extraction of P from sewage sludge or ash; and extraction of N through various forms of ammonia release and capture. Both simple and complicated approaches are explored still today. Today's inventions are extremely technology intensive that includes extraction of nutrients from sewage sludge or sewage sludge ash and so on.

Multiple uses for carbon

Human excreta bear carbon that could improve soil fertility. The past sewage treatment turned these fractional carbons into biogas and carbon dioxide by microbial metabolism or incineration process. On the other hand, carbon can be treated in other way for more variety of use. Human feces can potentially serve as feedstock for the production of biocrude, bioethanol, biodiesel, biohydrogen, and syngas. Feces can be also utilized as feedstock for the production of higher-value industrial chemicals. These different method of recovery of carbon doesn't necessarily prevent each other. Processing for the production of energy carriers or higher-value chemicals will results in less availability for carbon to be used in agricultural use, therefore less improvement of soil quality.

Greenhouse System

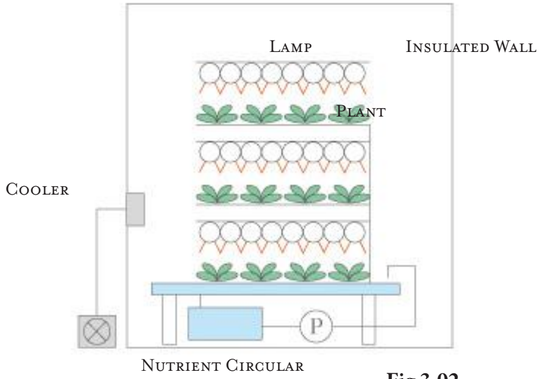


Fig 3.02

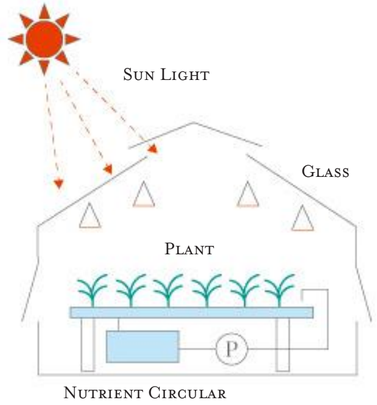


Fig 3.03

Artificial Light Based Type

This type of hydroponic cultivation will use completely isolated and insulated room. Artificial light is utilized as a main light source and the growths of the plants are independent from sunlight variation. This allows stacking cultivation rack which increases the harvests per area. Such closed environment facilitates controlling ideal settings for growing plants and make it easy to plan out crop amount throughout the year. This type can be located any where because of controlled environment inside.

Sunlight Light Based Type

Sunlight based hydroponic cultivation utilizes sunlight as a main light source but also uses artificial lighting as it's needed when there are not enough lights from outside. Cultivation racks cannot be stack on top of each other in a consideration for sunlight distribution. But introducing sunlight will allow growing various kinds of produces unlike the artificial light based type where it is mainly used for raising leaf vegetables.

Water Cycle

Water is supplied to pants and some will be absorbed. Water evaporates from leaves and diffused in air. The air will be dehumidified and collected water will be again supplied to plants as nutrient solution.

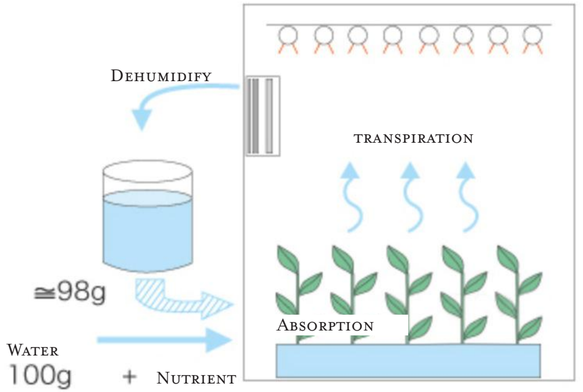


Fig 3.04

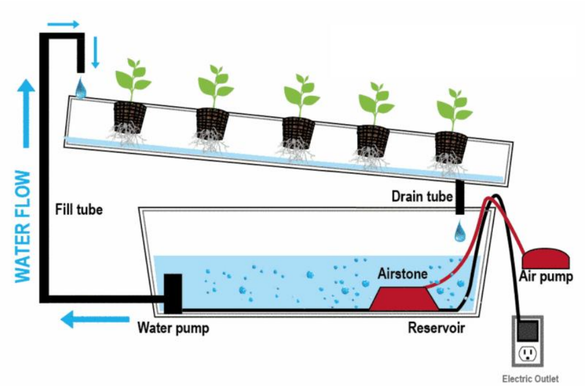
Advantages to Utilize Hydroponic Cultivation

Stability
-the price and quality of produces are consistent throughout the year

High Hyginene
-No needs for cleaning dirt
-Less risks for bug infestation

High Quality
-There will be less germs and longer duration till it spoils

Functionality
-Produces will contain more vitamins
-Ability to have control on specific nutrients



The nutrient film technique (NFT) is what most people envision when they think of hydroponic farming. This system provides the plants with nutrients on a constant basis and does not need a timer.

The nutrient solution is continually supply to the growing tray then drains back to the reservoir underneath.
The NFT does not use a growing medium at all. The plants are growing in pots or other container that allow the roots to grown down into the nutrient solution.

NFT System

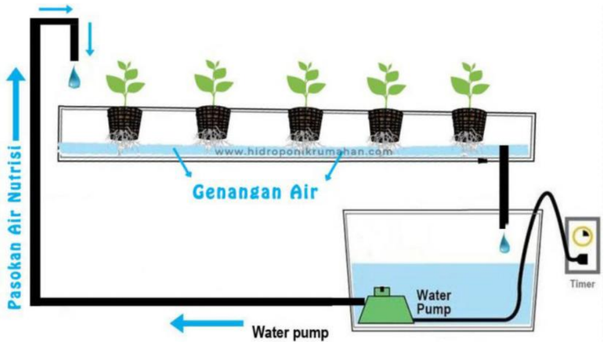
Pro

- Lower water and nutrient consumption.
- Avoids the supply, disposal and cost problems associated with media based systems.
- Relatively easy to disinfect roots and hardware compared to other system types.
- The absence of medium makes it easy to inspect roots for signs of disease, feed adequacy, etc.
- Regular feeding (and associated flushing) prevents localized salt build-up in the root zone and maintains uniform root zone pH and conductivity.
- Environmentally friendly - minimal potential for localized groundwater contamination.

Con

Pump failure can result in plant death within a few hours, especially in hot weather.

- Not suitable for plants with large tap-root systems (e.g. carrots).
- Compared to run-to-waste systems, it is less suitable for saline (salty) waters because the salinity of the recirculating water gradually increases.



Roots of the plants are entirely covered in nutrient solutions. Since root is not exposed to the air, introducing air pump must be taken into consideration in order to prevent root rot and promote smooth growth. In this system, unused solutions will remain in the growth tray, thus water pump doesn't have to be turned on all the time instead the pump will operate by timer.

DFT System

Pro

-Since pump works only once in a while, it can save electricity
-Even if electricity supply was cut plant can feed on the nutrient that is left in the tray.
-This system can be adapted to various kinds of hydroponic cultivation system

Con

-fairy expensive
-bigger amount of nutrient is necessary to run this system compare to NFT
-chance to get root rot due to lesser oxygen supply

Expected Costs and Water Use in Green House

Water Cost	$3 per square meter
Fertilizer	$6-7.5 per square meter
Seed	$5.4-6 per square meter
Paraffin oil(room temperture12°C)	$3 per square meter
Electricity(machine cooling)	$10 per square meter

Average Water Usage in Japan

Single House hold

Average water use of single person in one unit	8.0 m^3 per day
Average costs of tap and sewage water	$15-20 per month

Two Person House hold

Average water use of two persons in one unit	16.2 m^3 per day
Average costs of tap and sewage water	$35-40 per month

Three Person House hold

Average water use of three persons in one unit	20.8 m^3per day
Average costs of tap and sewage water	$45-50 per month

Four Person House hold

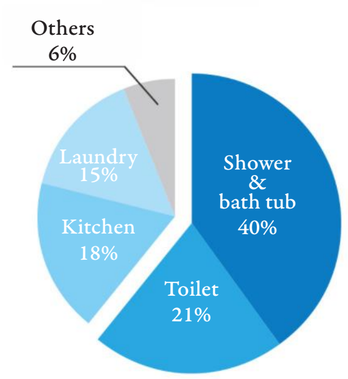
Average water use of Four persons in one unit	25.1 m^3 per day
Average costs of tap and sewage water	$60-65 per month

Four Person House hold

Average water use of water in Japan is about 290L according to Ministry of Land, Infrastructure, Transport and Tourism.

Evident Water Use in Shower

290L of water were used for followings; bath 40%, toilet 21%, kitchen 18%, laundry 15%, others 6%.



Site Analysis

Fig 4.01

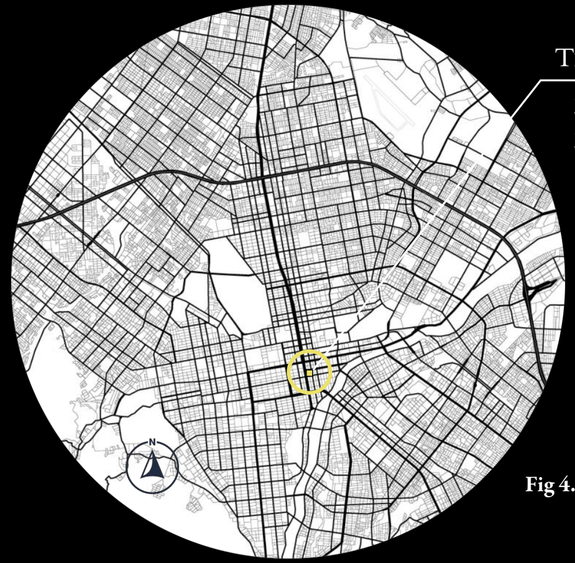


Fig 4.03

Fig 4.02

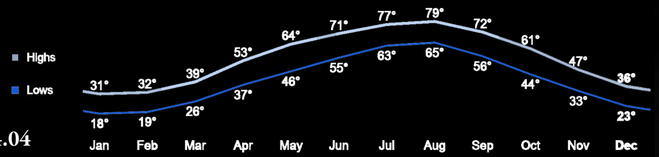
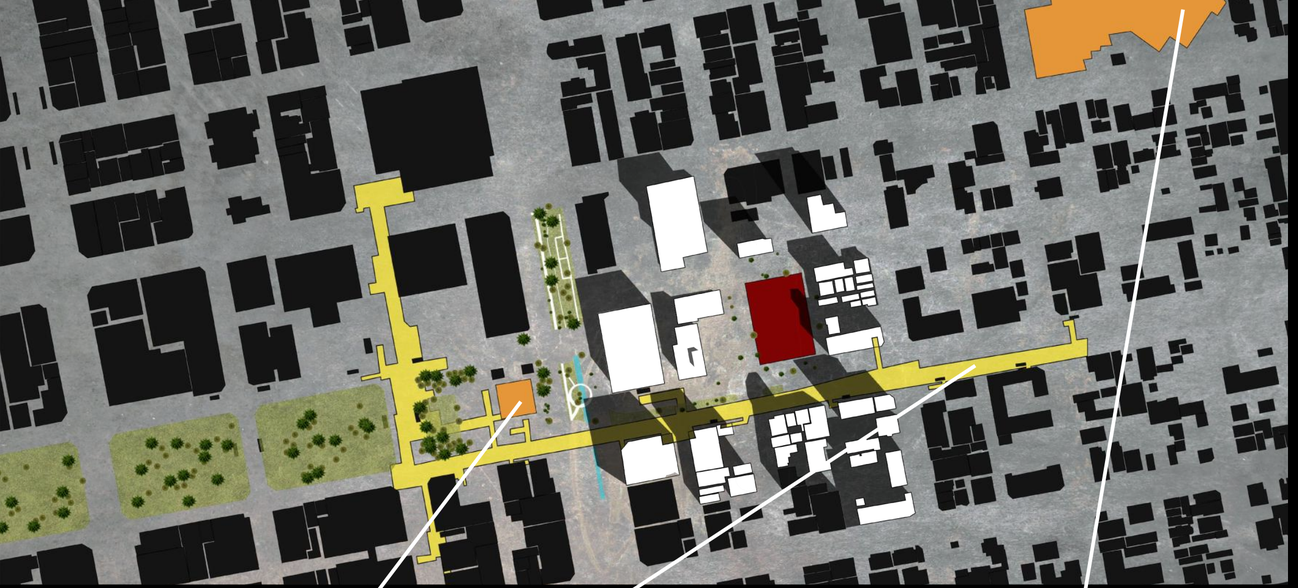


Fig 4.04

The Site Selection

When taking look at a list of developed countries by the Human Development Index, many countries with high GDP values can be recognized. Self-sufficiency does not necessarily follow the level of the Human Development Index. Japan was one of the first countries that are listed as top tier in its development and has a low self-sufficiency rate. This means that Japan is depending on the food sources of other countries, even with the fact that this country often faces a supply crisis by earthquake damage. This building concept will help stop relying on food supply sources in other countries.



TV TOWER

SUBWAY

UNDERGROUND WALKWAY

SAPPORO FACTORY

(MALL)

N

Zoning

Heighborhood Commercial Zone is surrounding the site aolong with the mainroad where the street is lively, whereas it will be mostly very peaceful and calm in the middle of the area that is boardered by the commercial zones.

RESIDENTIAL

NEIGHBORHOOD COMMERCIAL

CATEGORY II RESIDENTIAL

QUASI-RESIDENTIAL

Fig 4.11

Residential Zone

Mid to high rise buildings can be built in this area. There are no height limits. Allowed typologies in the area are residential, hospital, library, shrine, temple, and any commercial building, and office building that are within 2 story high and floor area of 500 square meter.

Neighborhood commercial Zone

There are less limits set for this area. There are no area limit on floor planning of shopping store, office and theater, and movie theater. Factory with less than 150m^2 and has no danger to harm neighboring environment, and car factory with less than 300m^2 could be built in this area.

Category II residential zone

This land areas are mainly intended to design protected environment for residential living. In addition to the buildings allowed in Category II residential zone, bowling and skate facility, and some other leisure facilities with less than 10000m^2.

Quasi-residential Zone

This area is often adjacent to state road or highway, and the land use is intended to synthesize automobile related facilities and protected neighboring residential living. In addition to the buildings allowed in Category II residential zone, car warehouse, warehouse, car factory with less than m^2 of working floor area, theater and movie theater with less than 200m^2 of auditorium seating area.

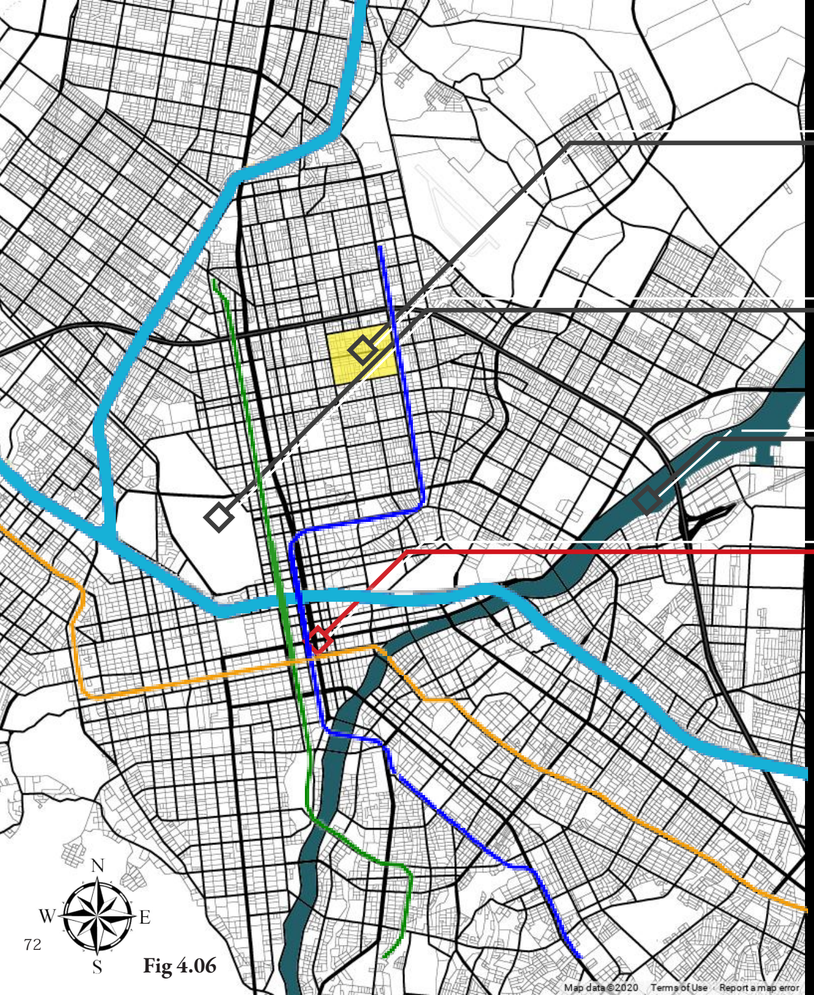
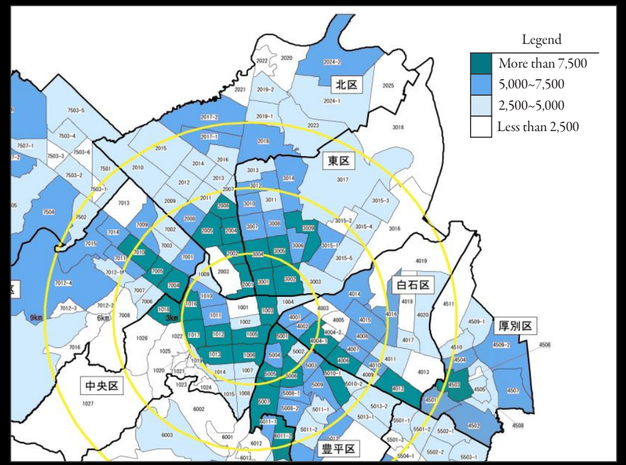
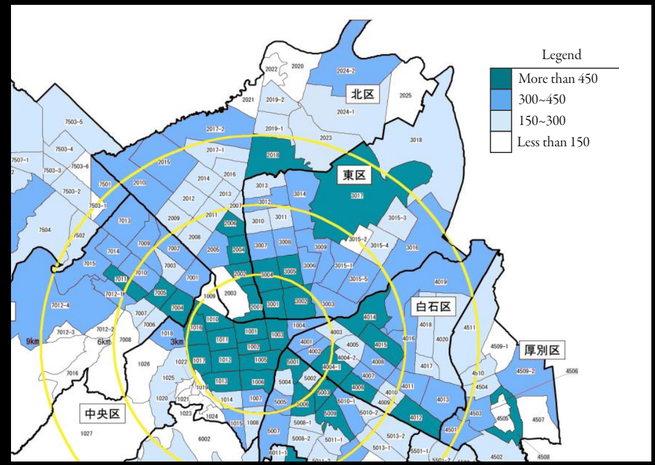


Fig 4.06



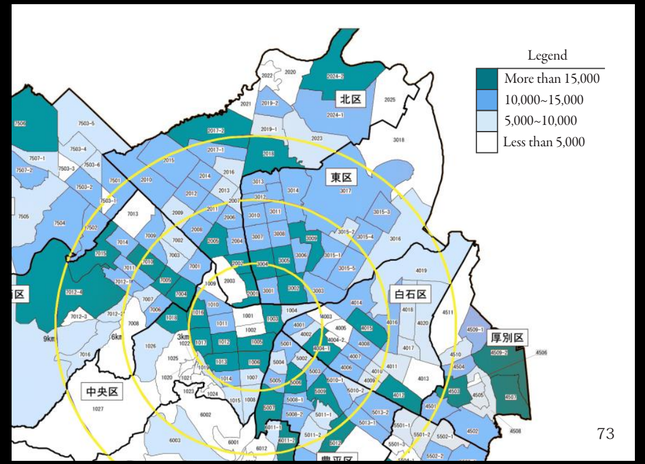
HOUSEHOLD MAPPING

Fig 4.07



OFFICE MAPPING

Fig 4.08

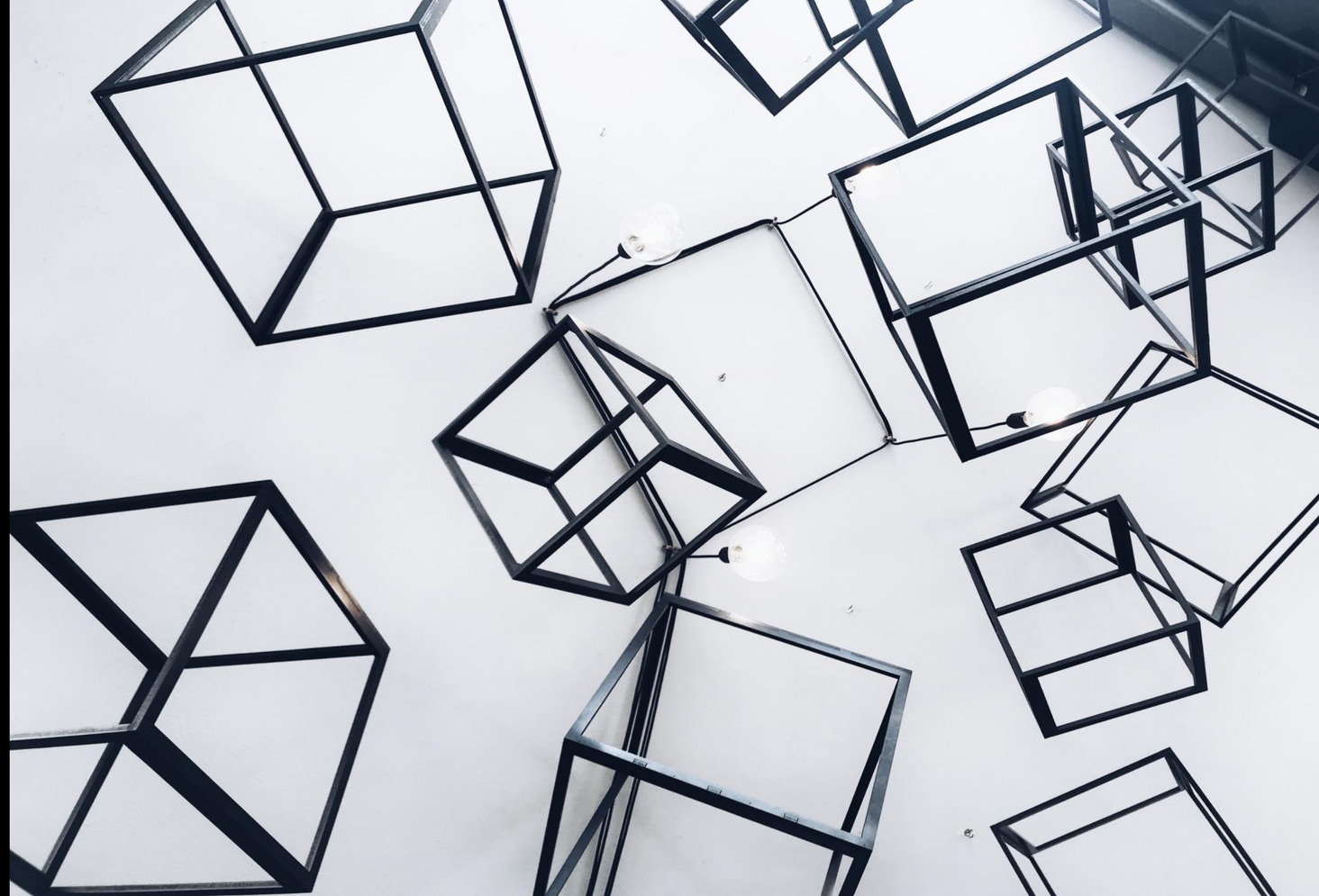


POPULATION MAPPING

Fig 4.09

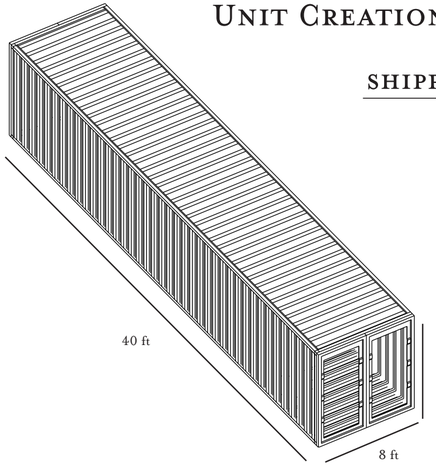
The site is moderately populated and has decent amount of household in the mapping area. Considering the land use, and the population, household numbers, we can say that this area is mostly residential, and businesses and institution that serves around the area is mostly targeted the middle-income population such as grocery store, hospital and school.

Design Process



Unit Creation

SHIPPING CONTAINER



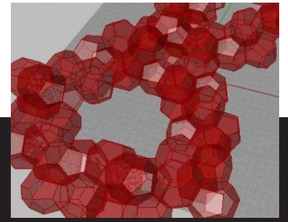
Advantages

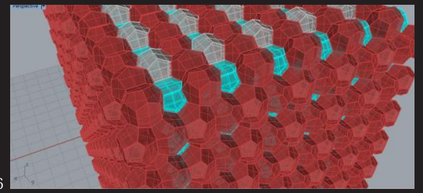
- Easy unitization
- High compatibility and mobility
- Big room for customization
- Many applications

Disadvantages

- Low R value
- limitation on the size and space

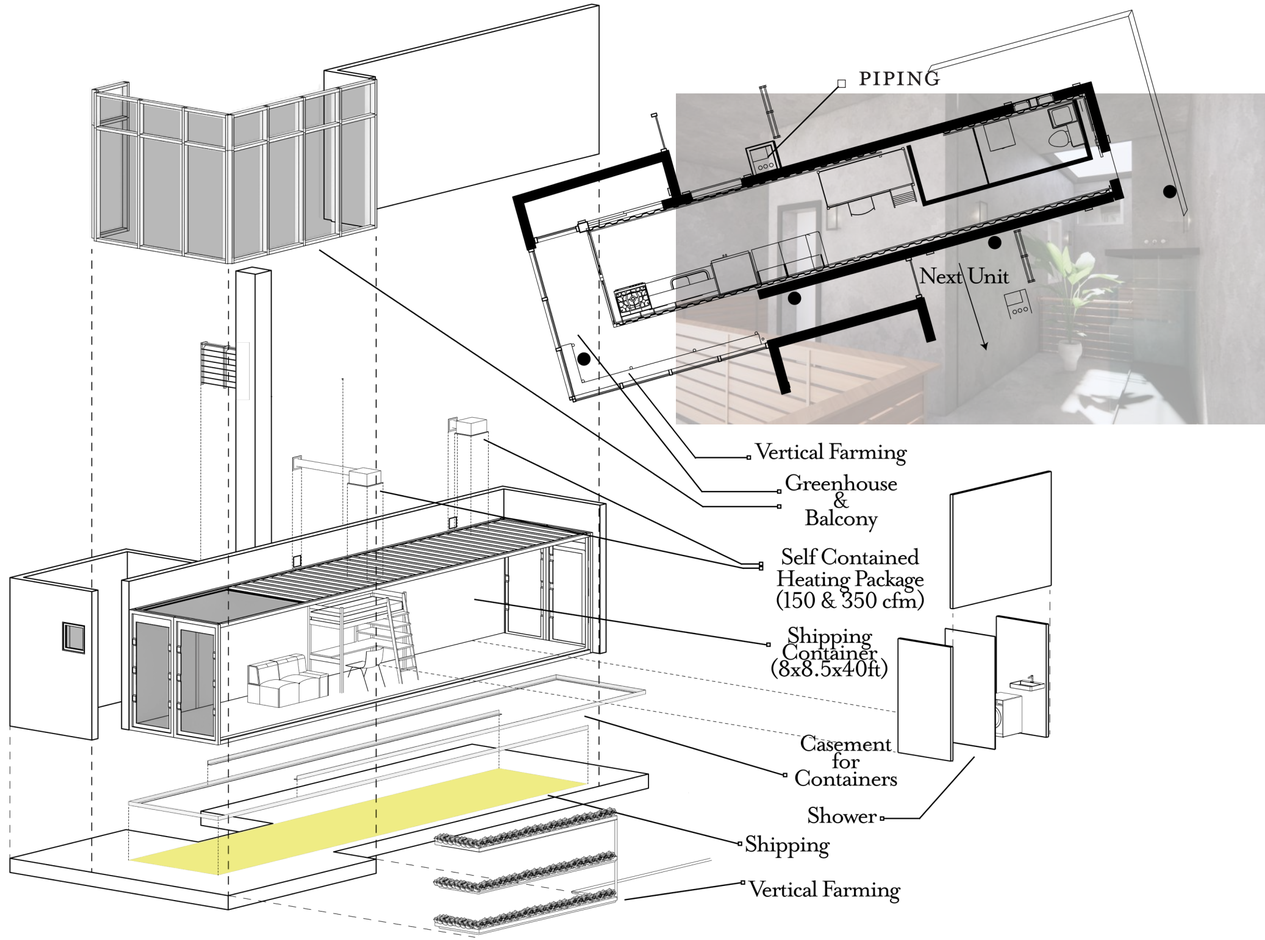
Applicatrion for a retail store





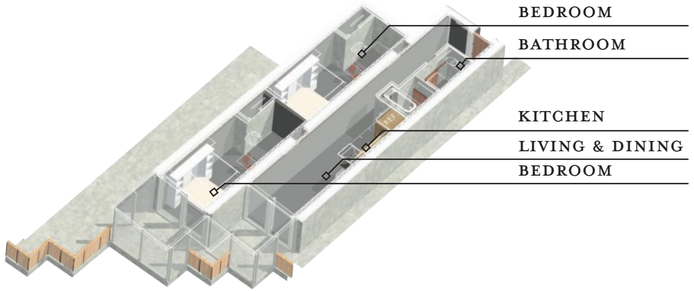
← SOME OTHER IDEAS ON UNITIZATION

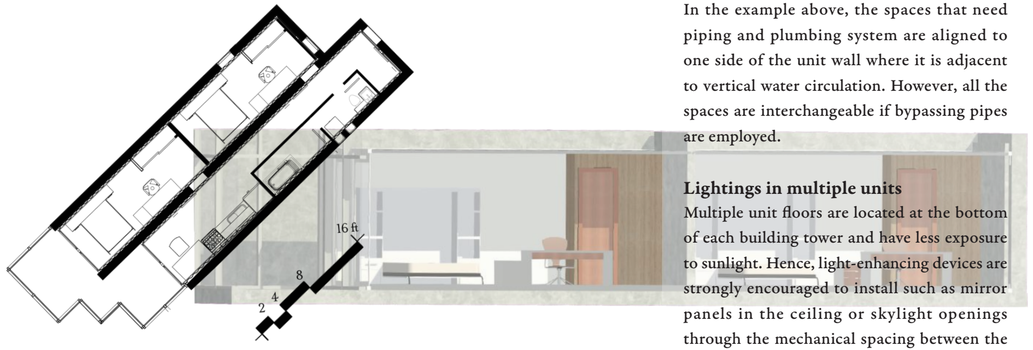
The geometries support the volumetric village by its surface and complex interaction with surrounding environment



Two Unit Household

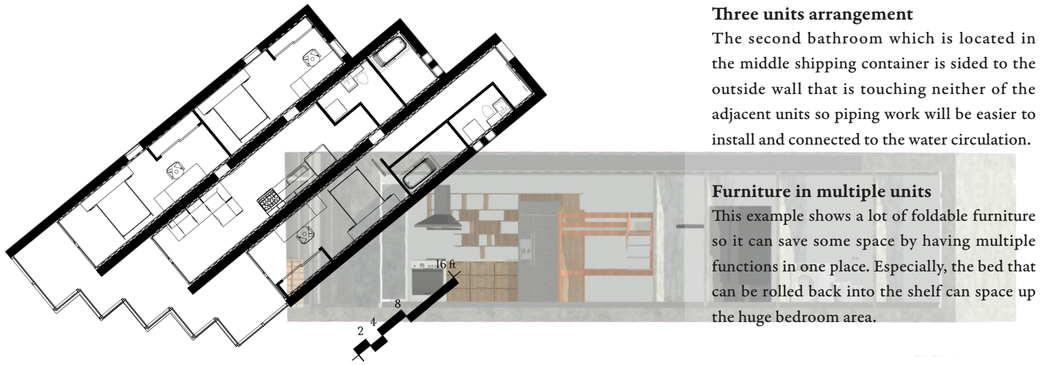
ONE BATHROOM UNIT
TWO BEDROOM
SINGLE KITCHEN
SINGLE LIVING ROOM





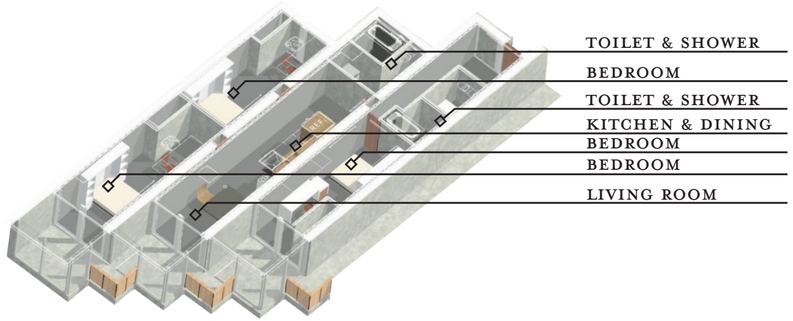
Two units arrangement
In the example above, the spaces that need piping and plumbing system are aligned to one side of the unit wall where it is adjacent to vertical water circulation. However, all the spaces are interchangeable if bypassing pipes are employed.

Lightings in multiple units
Multiple unit floors are located at the bottom of each building tower and have less exposure to sunlight. Hence, light-enhancing devices are strongly encouraged to install such as mirror panels in the ceiling or skylight openings through the mechanical spacing between the the shipping container ceiling and the floor above.



Three units arrangement
The second bathroom which is located in the middle shipping container is sided to the outside wall that is touching neither of the adjacent units so piping work will be easier to install and connected to the water circulation.

Furniture in multiple units
This example shows a lot of foldable furniture so it can save some space by having multiple functions in one place. Especially, the bed that can be rolled back into the shelf can space up the huge bedroom area.

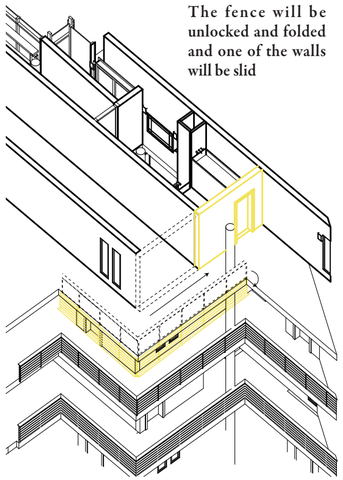


Three Unit Household

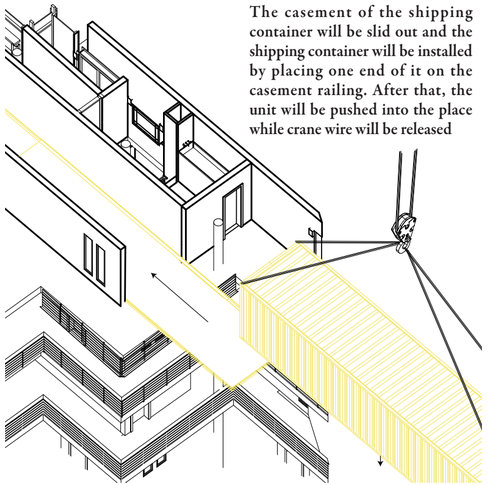
TWO BATHROOM UNIT
THREE BEDROOM
SINGLE KITCHEN
SINGLE LIVING ROOM

INSTALLATION

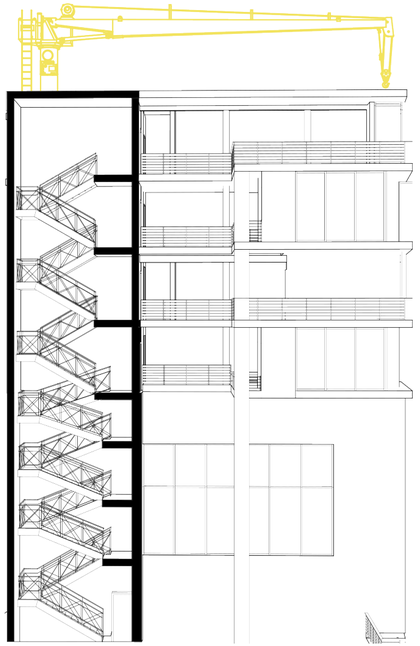
Wall and Fence Removal & Installation



The fence will be unlocked and folded and one of the walls will be slid



The casement of the shipping container will be slid out and the shipping container will be installed by placing one end of it on the casement railing. After that, the unit will be pushed into the place while crane wire will be released

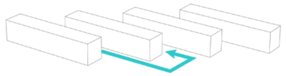


Crane & Vertical Circulation

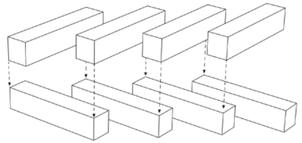
The crane is located on top of the core structure in the middle building which is located on both ends of the rooftop. This placing will cover the installation of shipping containers for the whole building while reducing the dead load of the floors.

SPACIAL ARRANGEMENT

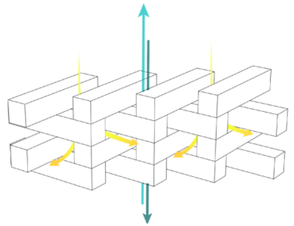
INITIAL SPACE IDEATION



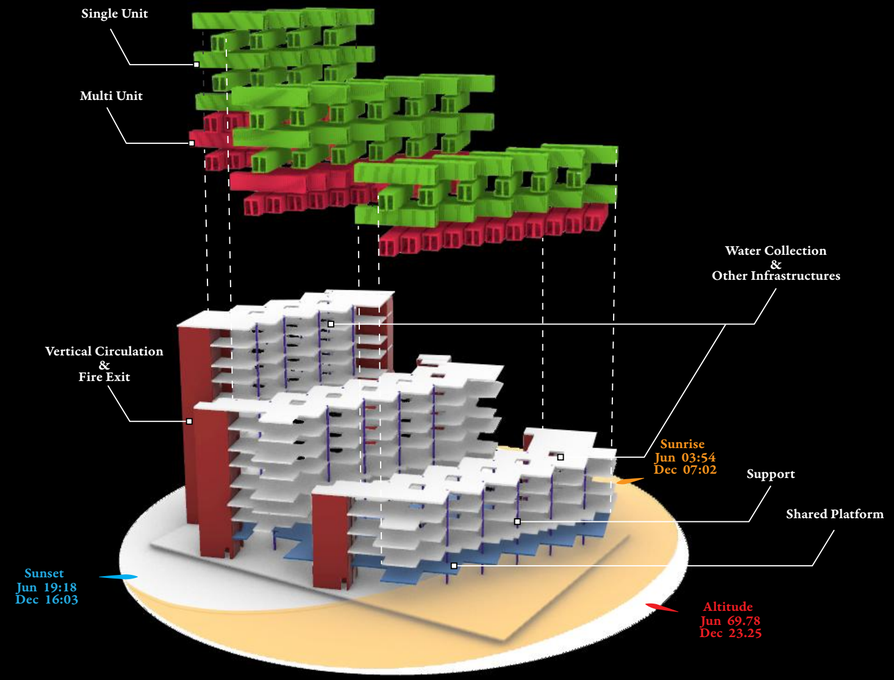
HORIZONTAL WATER CIRCULATION



STACKING EDGE TO EDGE

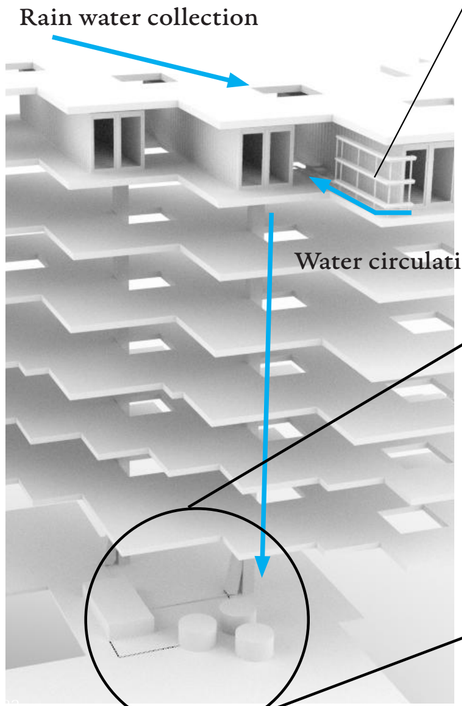


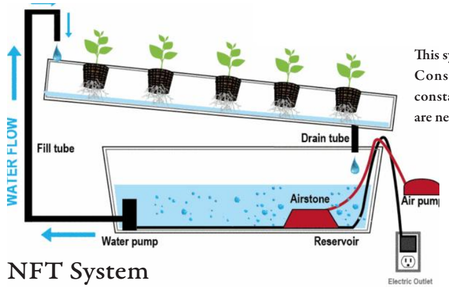
VERTICAL WATER CIRCULATION & SUN LIGHT DIFFUSION



TOTAL SPACIAL ARRANGEMENT

The single units are placed on the upper parts of the stacking structure since they have the VF system in the balconies where they need more sunlight exposure. The vertical circulations of each tower are located at both ends of the floors where it not only helps the egress access to the entire building but also giving support for the structure. The sun path on the site is considered for the spatial arrangement of shipping containers and orientation of the building.



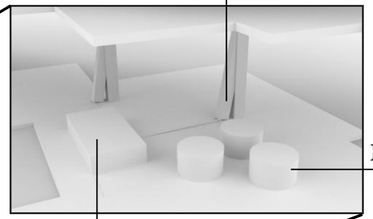


NFT System

This system prevents roots to grow rotten. Considering the usage of gray water constant water circulation and filtering are necessary for total system design

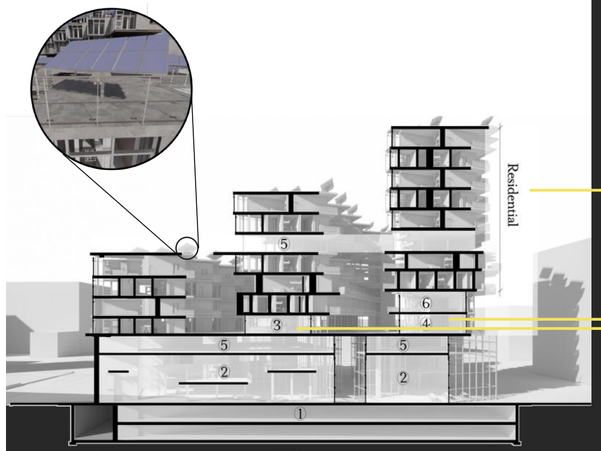
Water turbine electric generator

Graywater go through water turbine when it's dropped from upper floors and it goes through filteration and redistributed for farming and fish farming



Filtering System
&
Purification System

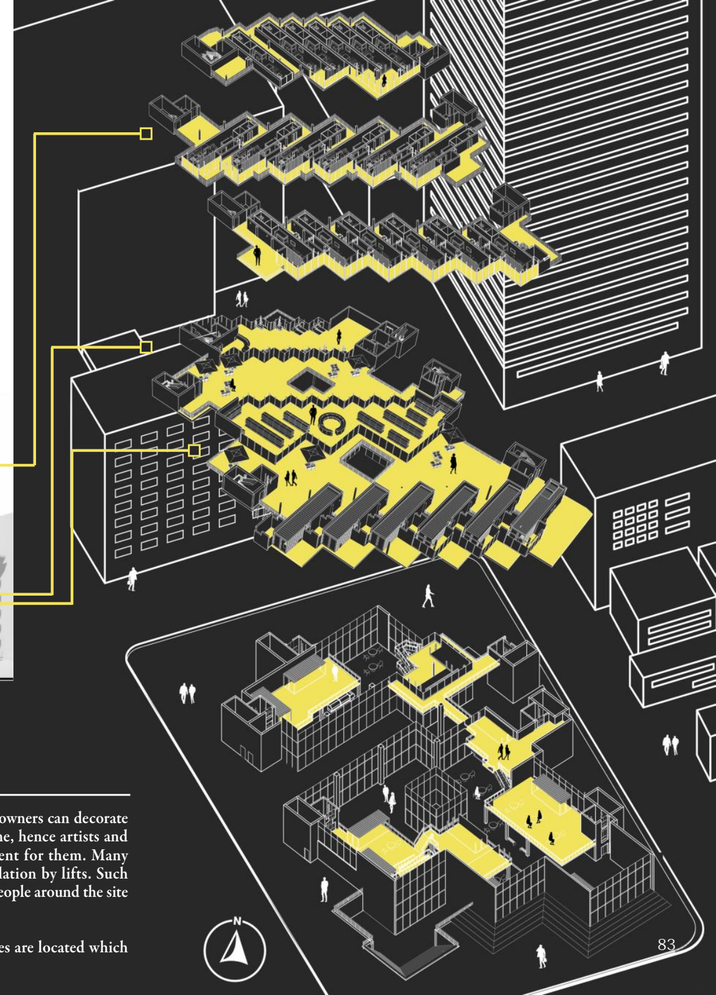
Fish tank



1 Parking
2 Exhibition & Retail
3 Convenience Store
4 Gym
5 Resource Processing Floor
6 Community Space

The ground floor serves as an exhibition area and retail area where artists or business owners can decorate shipping container units and install them. Such installation could be done at any time, hence artists and business owners could ship the fully decorated units to the site whenever convenient for them. Many interesting events could take place because of the flexible installation and uninstallation by lifts. Such footless display units will help organizers to have an exhibition theme that will attract people around the site area.

There is a shared platform on the second floor where the gyms and convenience stores are located which gives the residents better quality of life.



RESIDENTIAL FLOOR

4 8 16 32FT

N

FIRST FLOOR

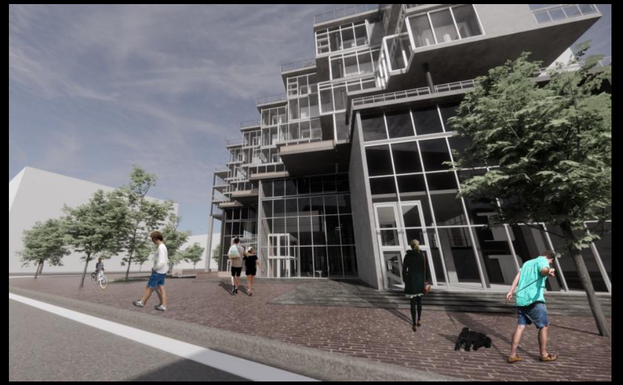
(EXHIBITION & RETAIL AREA)

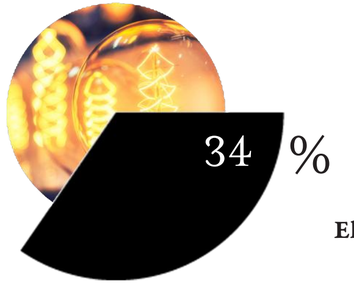
4 8 16 32FT

N

VIEWS IN UNITS

EXHIBITION AREA

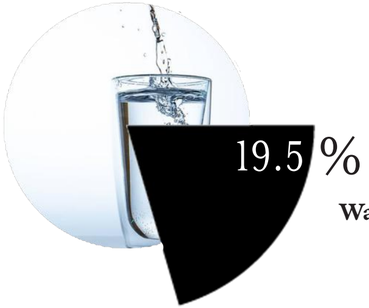




Electricity Self Sufficiency

Covers 30% of needs for residents

Using Solarpanel and water



Water Recycled

Grey water and rain water used in

VF system

Food Produces

Lettuce and herbs other leaf based

plants are raised

Thesis Appendix

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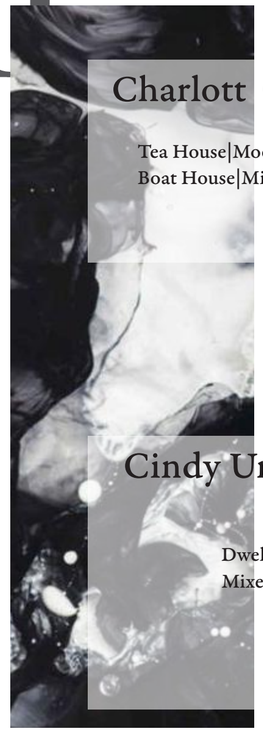
II



Charlott Greub

Tea House|Moorhead, MN
Boat House|Minneapolis, MN

Cindy Urness

Dwelling
Mixed Use

III

Mark Barnhouse

Tinber Structure
Entemology Lab|MN

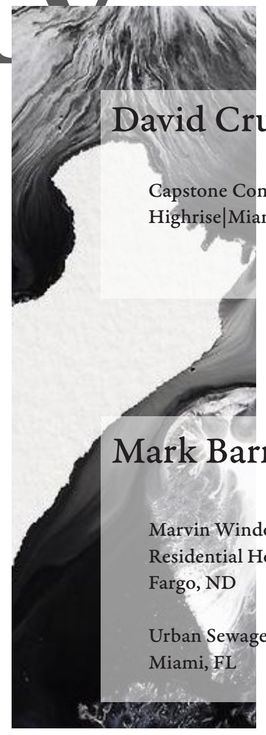
Masonry Structure4
Design Studio|Fargo, ND

Niloufar Alenjery

Fairy tail Competition

Native American Center
Moor head, MN

IV



David Crutchfield

Capstone Competition
Highrise|Miami, FL

Mark Barnhouse

Marvin Window Competition
Residential Houseing
Fargo, ND

Urban Sewage Design
Miami, FL

V

Ganapathy Mahalingam

App and Software Development

Thesis Design Studio
Sapporo, Japan

Studio Experience

Hajime Shibuya

hajime.shibuya@ndsu.edu