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Systemic Design for Regenerative Architecture in China

SYSTEMIC

Systemic design, hardly definable as a discipline itself, takes shape more as an orientation, as an emerging practice aimed at facing systemic problems through methodologies and approaches in a chorus that possesses a holistic vision and an oversight on multidisciplinary (Peruccio, et al., 2019).

DESIGN

Systemic Design is a design-based approach that outlines and plans the flow of matter running from one system to the others, pursuing a metabolization processes which should reduce the ecological footprint and generate profitable economic flows. (Bistagnino & Campagnaro, 2014)

FOR

REGENERATIVE

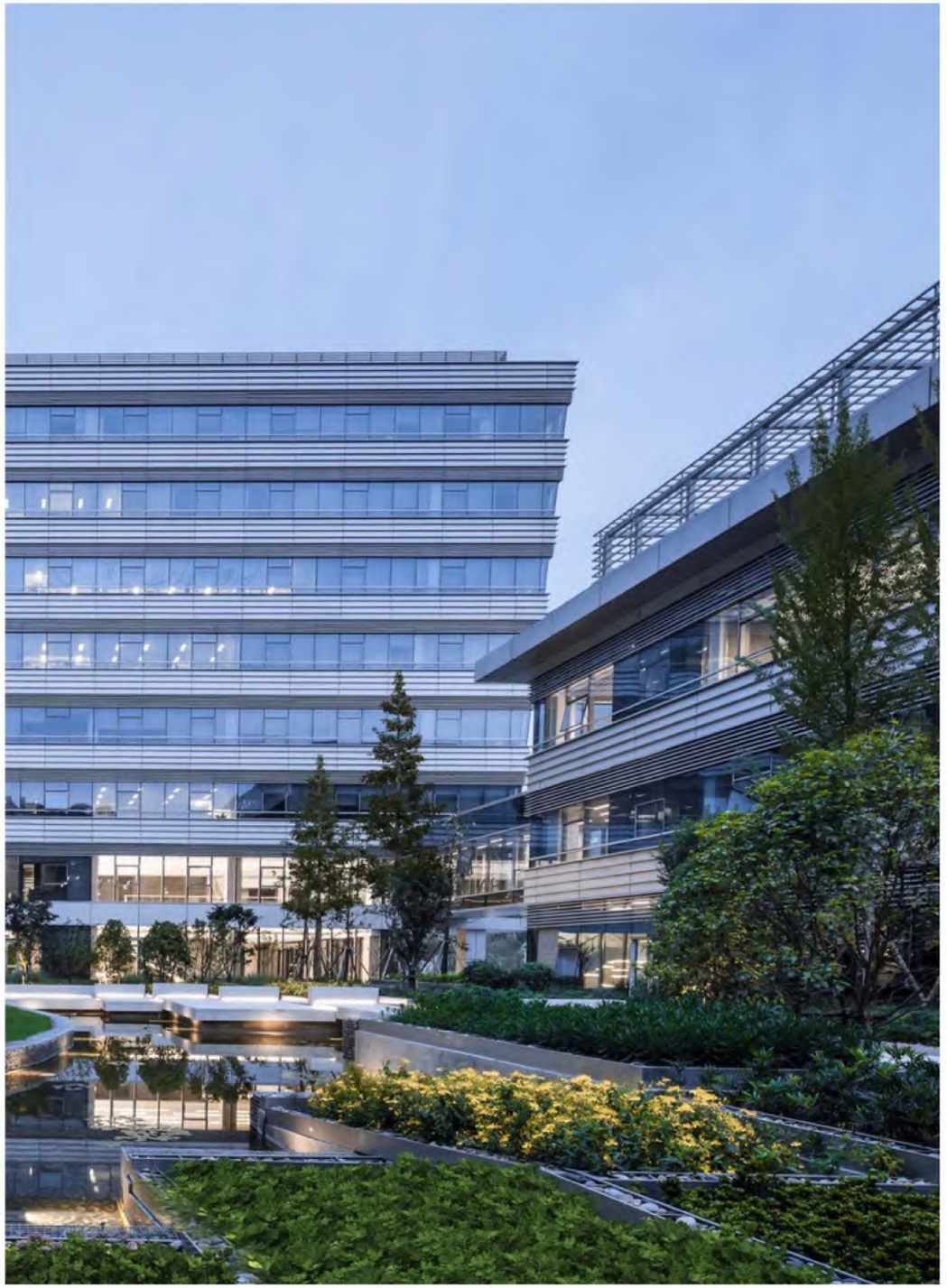
In architectural design, regenerative architecture is based on the premise that buildings can create value beyond their own consumption, as they can provide "food, energy, water, produce oxygen, and capture carbon dioxide" for humans (Littman, 2009).

ARCHITECTURE

In the concept of regenerative architecture, buildings rely on their environment for existence, and the environment can also benefit from the building and develop. They have formed an interdependent relationship, aimed at maintaining ecological balance and promoting growth, thus allowing humans to coexist harmoniously with the natural environment (Bonyad, et al., 2018).

IN

CHINA



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Abstract

Systemic design can be regarded as the integration of systems thinking and design. This thesis takes systemic design as a tool and focuses on elaborating the application of systemic design in the regeneration of recycled architectures in China.

With the rapid development of China's economy, environmental issues have become an increasingly concerned problem. The construction industry is particularly serious in terms of resource and energy consumption. It is hoped that this thesis can help more Chinese buildings and construction-related practitioners pay more attention to systemic design. The Integrated Management Building of Shanghai Automotive Industry Corporation Volkswagen (SVW IMB) is as an actual case and describes how to use the method of systemic design to intervene the regeneration of architectures in the design process.

The regeneration of Integrated Management Building is successful. Through the circulation of different energies and resources, the consumption of Integrated Management Building is reduced and the resources in Integrated Management Building are recycled, so that the employees of SAIC Volkswagen can also benefit from this circulation of resources and energy.

In the future, the systemic design method will continue to prevail in the field of architecture in China, helping the entire living or working place, people in China to obtain a better ecological system.

Key words： systemic design, ecological, regenerative architecture, SAIC Volkswagen

Abbreviations

Abbreviations	Meanings
SAIC	**S**hanghai **A**utomotive **I**ndustry **C**orporation
SVW	**S**AIC **V**olks**w**agen Automotive Co.,
VW	**V**olks**w**agen Automotive Co.,
MEB	Deutsch: **M**odularer **E**-Antriebs-**B**aukasten VW vehicle platform: Modular electric drive matrix
IMB	**I**ntegrated **M**anagement **B**uilding
IMB I	Integrated Management Building Phase 1
IMB II	Integrated Management Building Phase 2

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01

Introduction

Chapter One introduce primarily outlines the author's motivation and the main structure of the article.

This chapter introduce the research background , including the ecological challenge that the chinese archictecture are facing and systemic desgin is a suitable method to help the regenerative architecture desgin to optimize the influence from the architecture to the enviroment. Also the reason why SAIC Volkswagen Intergrated Management Building (SVW IMB) was chosen to be re-designed.

1.1 Motivation

Currently, Chinese architecture industry is still in the stage of emphasizing construction engineering and architectural design, without fully considering the important role of architecture in the ecological environment. This lack of systemic design thinking in architectural design has had a significant impact on the environment, resulting in a series of chain reactions.

The systemic design for architecture has different definitions in different academic studies, but the concept of continuous optimization of architectural design has always been constantly innovated and evolved around the topic.

The most important concept in modern architectural design is the ecological design concept. With the deterioration of the global ecological environment and the increasingly serious regional environmental pollution, the concept of ecology has gradually penetrated into all aspects of social development. At present in China, some architectural design enterprises have integrated the concept of ecological architectural design into architectural design. However, in current architectural design, more attention is paid to endowing buildings with functions such as saving resources, saving energy, reducing pollution, prolonging building service life and improving the ecological environment.

At the same time, more Chinese construction organizations or enterprises believe that designing a certain area of green environment around buildings is also an embodiment of the ecological design concept. This one-sided understanding completely distorts the concept of ecological design and thus affects the development of modern architectural design in China as a whole.

The author is current an employee in SAIC (Shanghai Automotive Industry Corporation) Volkswagen. As a world-renowned automobile enterprise, SAIC Volkswagen has been continuously promoting the cause of sustainable development. From automobile manufacturing to sales, the company is committed to taking the "zero-carbon road" as the goal and addressing climate change through green production and green operation. As the company's headquarters, the IMB (Integrated Management Building) is especially known for being a sustainable building.

However, merely a sustainable building is not the end of ecological design. In recent years, the concept of regenerative architecture has been frequently mentioned in China. The IMB can also serve as a very good regenerative case for reference in China's modern architectural field on how to renovate or design a regenerative architecture suitable for China's national conditions from the perspective of systemic design.

1.2 Objective and outline of thesis

In my thesis, the main object is the systemic design. Systemic design can be considered as a general design method to finish the design process of an object or a system, for instance the architecture design. According to the systemic design method, finally the object of design can achieve the purpose of the design process. Through the systemic design, the purpose how people make and the process how people work will be detailed introduced in the chapter Two.

My thesis is organized as six chapters and in the first chapter is the introduction of motivation and objective, elucidate why the author wants to combine Chinese architecture with systemic design. The second chapter is about the state of the art, the part of theory, the definition of systemic design and regenerative architecture. In this chapter in addition to defining the two key terms, the translation also includes a comparative analysis of the differences with other similar terms. The third chapter analyze the current problems of Chinese architecture from systemic design perspective. The fourth chapter describes the methodology, how people work with systemic design and how to apply systemic design. The fifth chapter uses the SAIC Volkswagen Integrated Management Building (SVW IMB) as a carrier, and through the methodology of systemic design, transforms SAIC Volkswagen Integrated Management Building into a regenerative architecture. The final chapter summarizes the key points of the entire thesis, obstacles and outlook how systemic design can continue to play a role in Chinese architecture in the future.

02

State of the Art

This chapter focuses on elaborating the definitions of systemic design and regenerative architecture, and differentiates between the definitions of regenerative architecture, sustainable architecture, and green architecture.

The design process of regenerative architecture is based on systemic design. Regenerative architecture not only pays attention to environmental, ecological, and resource aspects but also emphasizes the relationships between social, economic, and natural systems.

It encompasses not only the impact of the building's resources but also the humanistic effects on the people who work or live in the building and those in the surrounding neighborhood. Additionally, it considers the impact on the ecosystems within the building and the surrounding ecosystems centered around the building itself.

2.1 Systemic design

Systemic design (Xitongxing sheji 系统性设计/系统型设计) is a comprehensive design approach that emphasizes considering all aspects of the entire system, including environmental, social, economic, and technological factors, during the design process. Systemic design, hardly definable as a discipline itself, takes shape more as an orientation, as an emerging practice aimed at facing systemic problems through methodologies and approaches in a chorus that possesses a holistic vision and an oversight on multidisciplinary (Peruccio, et al., 2019).

The idea and method of systemic design is a powerful tool for the rationality of modern design and the creative process of design. It brings design into the rational track of science and makes perceptual and intuitive design become an orderly part of the whole system. From the aspects of technology and aesthetics, the design is made concrete through systematization, and the rational system method is integrated with the intuitive and perceptual design thinking, to perfect the design.

Also systemic Design is a design-based approach that outlines and plans the flow of matter running from one system to the others, pursuing a metabolization processes which should reduce the ecological footprint and generate profitable economic flows. The project plans and optimizes all the actors and parts of an ecosystem allowing for their coherent and mutual evolution. (Bistagnino & Campagnaro, 2014)

2.1.1 Definition

Systemic design is an interdisciplinary practice that produces human-centered solutions by incorporating systemic thinking into design methodologies. Systemic design intends to develop multiple new practices based on intersections of multiple perspectives (Sevaldson, 2019). Systemic design integrates systems thinking and theory with advanced design methods in an evolving interdisciplinary field to effect anticipatory change in complex social, sociotechnical, and social systems (Jones, 2020). Obviously, systemic design aims to introduce systemic thinking in the design stage and analyze design requirements from more perspectives, so as to complete designs that can meet the demands from more people, environments, and other factors.

A system is an ordered whole with specific functions, interconnections, and mutual constraints. Systemic analysis is a prerequisite for modern design:

- The system is a whole composed of two or more elements; There is a certain organic connection between these elements, between the elements and the whole, thus forming a certain structure and order inside and outside the system.
- For systemic design, it should be regarded as the essential attribute of design, and design should not be a part of the whole. When designing a product, the design not only creates the product itself, but also creates the various relationships that interact with the object, and these relationships and everything around them constitute a large or small system.
- Systemic design requires that we cannot use a one-sided angle to look at the problem, to put everything in the connection. This requires us to analyze how a system works and how actions work before we design it.

The significance of systemic design is to conduct in-depth systemic analysis of the elements and environment of the design object, to deeply understand the situation of the

design object, and to carry out targeted design of the design object according to the situation. Of course, in the process of system analysis, it is also necessary to understand the interrelated elements or combinations of systems, not only what they are and what they do, but also how they work together and their effects on each other.

In summary, systemic design considers the following seven key points:

1. Holism: Systemic design considers the entire system rather than just individual parts or components in isolation.
2. Interconnectedness: It acknowledges the interplay and interdependence among the various parts within the system.
3. Adaptability: The design considers the system's capacity to adapt to changes, ensuring that it can flexibly meet future demands.
4. Sustainability: It pursues long-term health and efficiency of the system, not just short-term solutions.
5. Feedback Mechanisms: The design includes feedback loops that allow the system to self-adjust and optimize based on feedback.
6. Interdisciplinary Integration: It combines knowledge and techniques from different fields to comprehensively address complex issues.
7. Stakeholder Engagement: The design process considers the needs and perspectives of all stakeholders.

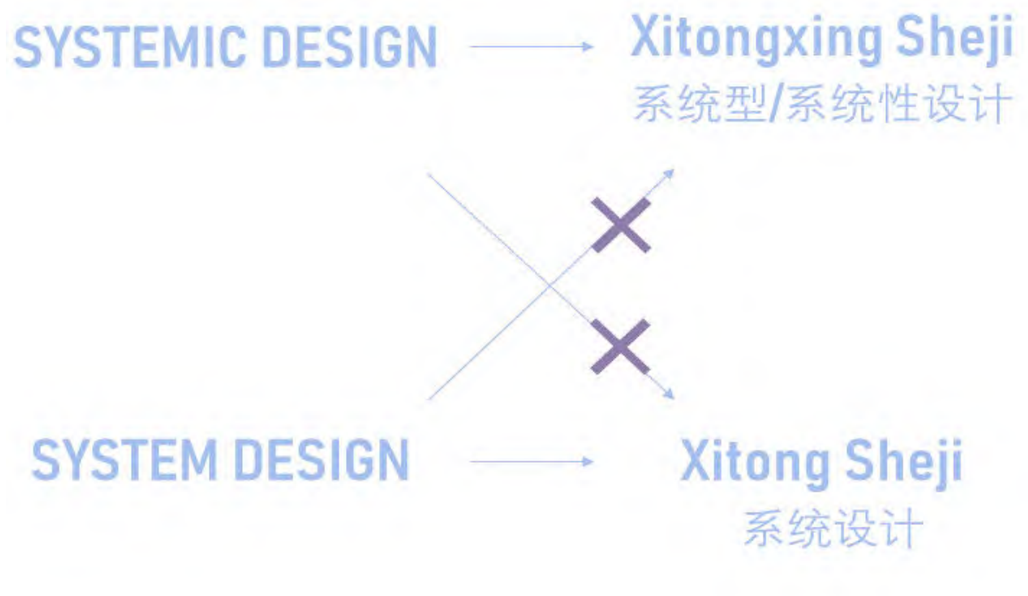


Figure 1 : Systemic design translation in Chinese, drawn by author

In Chinese, as shown in *Figure 1*, systemic design (Xitongxing Sheji 系统性设计/系统型设计) is often translated into Xitong Sheji(系统设计), which may actually lead to people's misunderstanding. A more accurate translation of systemic design should be Xitongxing Sheji(系统性设计/系统型设计).

Systemic design differs from the commonly designated systems design in that systemic design is a design field (systemic as the modifier of design) and systems design is the design of systems as objects, a practice developed through systems engineering (Jones, 2020).

While systemic design can be simplistically defined as the application of systems approaches to advanced design problems, the field has taken shape as an advanced design discipline, embracing architecture, planning, and social research as critical adjacent practices for its applications. Systemic design studies reveal an overarching scientific philosophy of pragmatism, embracing multiple perspectives to describe a system and its problems and structures (Jones, 2020).

2.1.2 Consideration

Systemic design provides a thought tool and method for modern design to analyze and study design objects and related problems from the whole, global and mutual perspectives. At the beginning of the design, the product function, specifications, uses, market, user needs, environment and enterprise equipment, technical conditions, economic conditions of many aspects of the system analysis, on this basis, in order to make a reasonable creative design and concept.

2.2 Regenerative architecture

2.2.1 Regenerative architecture

In biology, regenerate refers to the ability of organisms and ecosystems to renew, restore, or grow tissues in response to natural fluctuations. When applied to architectural design, it is akin to mimicking nature's self-healing mechanisms.

Regenerative architecture refers to the use of nature as the medium and generator of architecture, and individual architecture as a part of nature and harmonious coexistence with the entire ecosystem.

The architecture is regarded as a part of the overall ecosystem, and the internal and external space of the architecture is used to organize various elements to realize the orderly circulation and transformation of matter and energy, so as to realize the high energy efficiency, low pollution and high environmental protection of the ecosystem. Its connotation expression has two meanings:

1. To provide a healthy, environmentally friendly and clean-living environment;
2. Effectively reduce energy consumption, protect and respect the natural environment.

Regenerative architecture is a forward-thinking approach, in contrast to sustainably designed architectures that are designed to reverse ecological damage and have a long-term positive impact on the natural environment. Moving from a sustainability perspective to a regeneration perspective means that designers should consider how to design architectures or objects that not only use limited resources, but also recycle them, while regeneration is a more resilient ability to respond to natural change. (Gattupalli, 2023)

The regenerative design process is basically based on a systemic thinking approach, and the design of regenerative architectures includes biotechnology that mimics nature, architecture surfaces that purify air, structures that purify water, and so on. The shift in thinking from sustainable to renewable architectures will provide better strategies for addressing the climate and biodiversity emergencies that plague society today. Regenerative architectures will enable the construction industry to do better, not just reduce adverse impacts on the built environment.

In architectural design, regenerative architecture is based on the premise that buildings can create value beyond their own consumption, as they can provide "food, energy, water, produce oxygen, and capture carbon dioxide" for humans (Littman, 2009). In the concept of regenerative architecture, buildings rely on their environment for existence, and the environment can also benefit from the building and develop. They have formed an interdependent relationship, aimed at maintaining ecological balance and promoting growth, thus allowing humans to coexist harmoniously with the natural environment (Bonyad, et al., 2018).

Through regenerative architecture, humans reconnect with their living spaces, and this architectural practice adopts the concept of comprehensive systemic thinking. The building is specially designed for the environment in which it is located and is considered a part of the ecosystem, helping to maintain the balance of nature and spiritually connecting the inhabitants to the place. Because of this close relationship, humans once again become co-partners in the health and success of the places and ecosystems we inhabit (Littman, 2009).

Table 1 : The principles of regenerative architecture (Littman, 2009)

The principles of regenerative architecture	**The criteria**
The 1st principle: Whole Systems Design Integration.	All systems and their elements are integrated into the whole system design. All systems are part of communities of mutually beneficial partnerships. Multiplicity: Each object inside the system should do more than one function or meet more than one demand. Redundancy: each requirement in the system is addressed by more than one solution.
The 2nd principle: Integration into the landscape.	The place's features and its landscape are the generators of the design. The building and landscape compliance adds a new unit or entity to the mix.
The 3rd principle: Intelligent limits.	Every program has a minimum required limit as well as a potentially infinite maximum. Reflecting the balance of the program. Each material and space is effectively maximized and integrated to make the greatest positive net contribution to the overall system.
The 4th principle: Concentration.	Less is more. Each place has been considered and is required. Flexible spaces/programmatic duality.

	The system is constructed using both natural and artificial means.
The 5th principle: **Intelligent construction**	The design is intended to enhance material efficiency. Construction and materiality embody the architectural image. Prefabrication/rapid prototyping.
The 6th principle: **Bold ecology**	Ecological systems are regenerative. Ecological production offers positive outcomes. Ecology incorporates all-natural factors as well as manmade elements. Energy is transcendent. Ecology is an image.
The 7th principle: **Community**	The scale has no impact on the significance of an entity or group. The design embodies the sharing of knowledge and social activity. Every member of the community participates in and influences the design.
The 8th principle: **Experience of place**	The image of the place creates a favorable experience. The perception of the place is powered by a certain systemic form. The place is accessible to both individuals and communities. The overall impression of the location is positive. The place tells a story.
The 9th principle: **Culture**	The design incorporates the social heritage of the place. Geological history is promoted and conserved. All current cultures are components of the place. Cultural resilience is accommodated. Design improves the quality of life for people of all cultures. The collective awareness of culture is tapped.

2.2.2 Sustainable architecture

Sustainable architecture gives the negative impact of architectures on the environment and society a solution by utilizing design methods, materials, energy, and development spaces that are harmless to the surrounding ecosystem or community, while adhering to social, economic, and ecological sustainability principles.

Sustainable design reduces or limits the use of resources as much as possible, while regenerative design supplements resources. However, the sustainability model can belong to a subset of the regeneration model, and both approaches overlap and contain similar practices, each emphasizing different green goals. Just as "reduce," "reuse," and "recycle" do not work in isolation.

The sustainable mode serves as the first step in the regeneration mode by limiting consumption and helps to achieve the goal of regeneration. One difference between the two approaches also lies in the way interventions are designed. Regenerative design requires the architecture to be seen as an extension of the site, flora, fauna, and ecosystem.

Architectures are seen as part of a larger system that helps nature or the environment produce and share resources such as clean water, energy, and food. For example, Splitterwerk Architects and Arup have jointly developed a project that uses solar heat to grow microalgae organisms in glass walls to generate renewable energy. The energy generated can be used by the architecture, stored for future use, or supplied to the utility grid.

2.2.3 Green architecture

Green architecture is simply an architecture designed to create a healthy living environment while reducing the adverse impact on the environment. This approach to design and construction prioritizes environmental responsibility, resource efficiency and the well-being of occupants. It aims to reduce the negative impact of architectures on the natural environment while promoting environmentally friendly practices and healthy energy consumption through technologies such as real-time rendering solutions.

The concept of "green architecture " is broad, paying special attention to the "environmental" attributes of architectures, and using all feasible measures to solve ecological and environmental problems (not limited to the principles and methods of ecology), which is a concept that is easier for the public to understand and accept. If there are environmental benefits, the efficient use of resources in the architecture.

Both regenerative architecture and sustainable architecture can be called green architecture, but green architecture are not necessarily regenerative architecture and sustainable architecture. It can be said that green architecture starts more from the dimension of results. If they provide certain environment-friendly and healthy contents for the natural environment or the users of the architecture, the architecture can be called green architecture.

2.2.4 The differences between green architecture, sustainable architecture, and regenerative architecture

Green architecture typically adopts active or passive features to reduce pollution and maintain sustainability. Most sustainable designs view architecture as their own containers rather than as part of ecosystems, and this approach is insufficient to support the current needs of the Earth. Merely maintaining the natural environment is not enough, of course, it is also necessary to repair the damage already caused during the construction process. Transitioning from a sustainable development perspective to a regenerative perspective means that architects should consider how we can design structures that not only utilize limited resources, but also restore them.

"Regenerative architecture" not only focuses on the "environment - ecology - resources" problem (the common ground of the above three), but also emphasizes the "social - economic - natural" feedback, involving society, economy, technology, humanities, and other aspects. Its connotation and extension are more rich, profound, broad, and complex than sustainable architecture and green architecture.

In short, from "green architecture", "sustainable architecture" to "regenerative architecture", it is a development process from extensive to professional, from low level to high level, and can also be understood as the highest stage of green architecture.

2.2.5 Consideration

From the perspective of design, regenerative architecture is based on systemic design at the early stage of architectural design, combining the architecture with the environment, ecology, resources, etc., and systemically thinking about the architecture and other elements.

When designing a regenerative architecture, it is important to adopt a systemic thinking approach. All relevant and contributing entities must be considered to measure their impact on the ecosystem. The design must consider the relationship between architecture and environment, architecture and ecology, architecture, and humanity, and must also allow for mutually supportive relationships between entities to ensure equal effort and gain. Every relationship is based on mutual relations, so regenerative architecture, or systemic design, is efficient and meaningful.

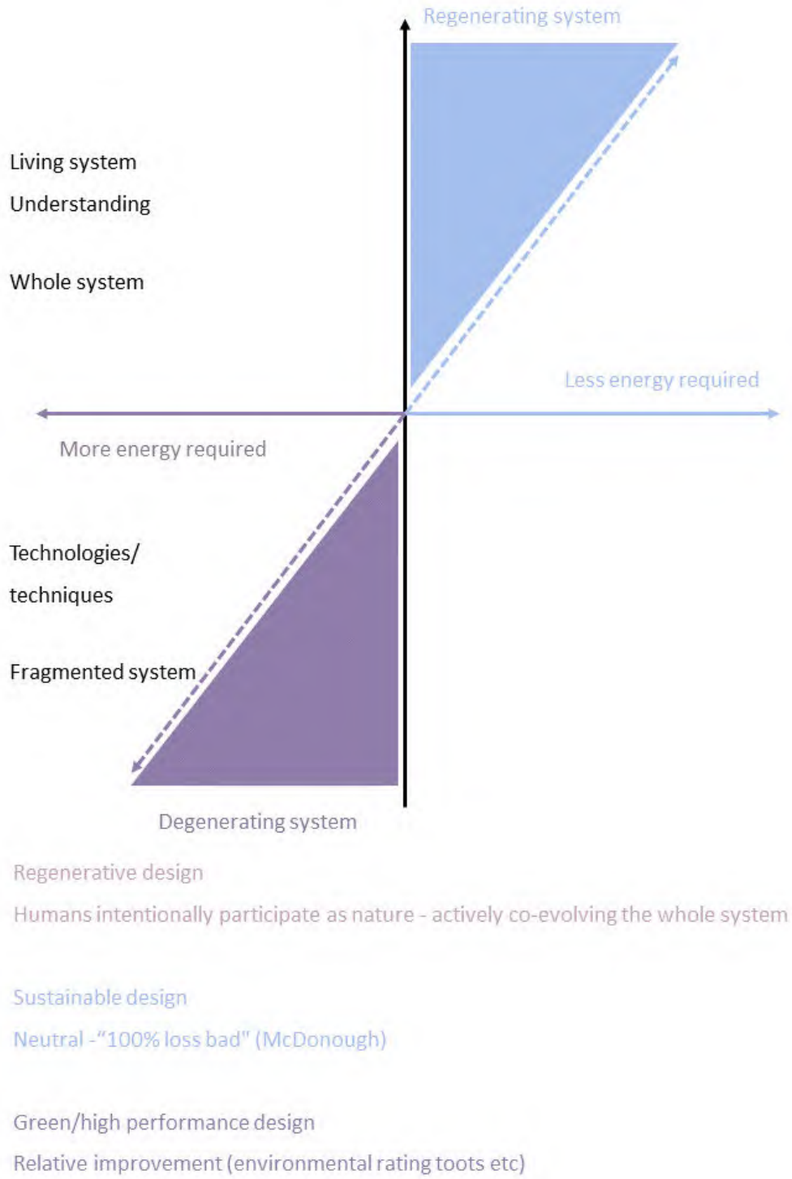
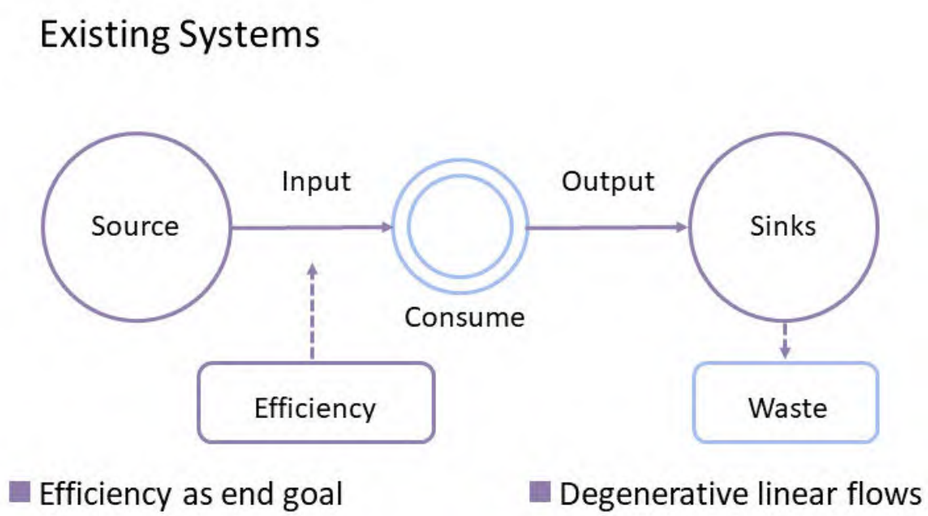


Figure 2 : The Trajectory of Environmentally Responsible Design and the transition from conventional to regenerative design range of sustainability approaches (Reed, 2007). Courtesy of the author



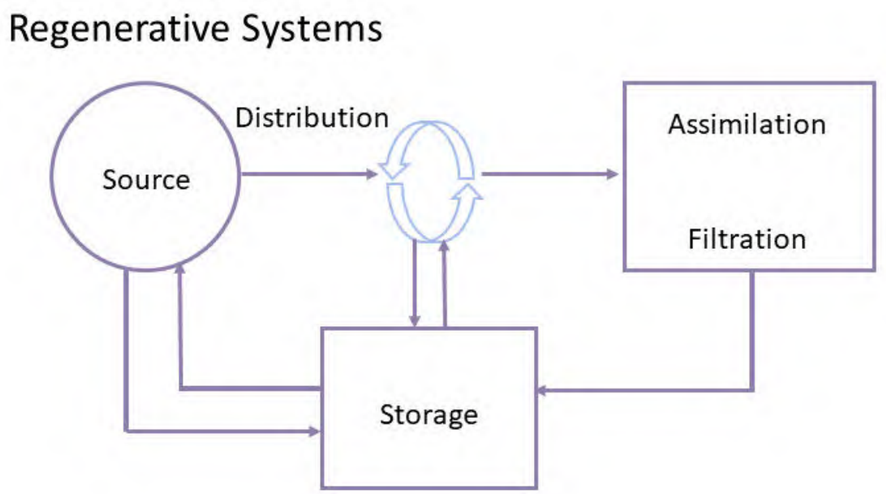


Figure 3 : Different between Existing systems & Regenerative systems processes (Flygare & Östlund, 2010)

The regenerative architecture concept goes beyond “less bad” or even “net-zero” design approaches to sustainability and aims at “net positive” design in architecture. It aims to regenerate systems with complete effectiveness that allow the co-evolution of humans’ built environment along with nature. The most influential factors in assessing regenerative building are: energy generation, water purification, material effeteness, responsible places, and indoor environmental quality (Baper, et al., 2020)

2.2.6 Outstanding overseas cases study of regenerative architecture.

Table 2 : Overseas cases of regenerative architecture conclusion

Project case	Architecture practices	Location	Eco-friendly design	Recycling of natural resources	Considering humanistic factors	Referential for IMB renovation	Meanings
BIQ House	Splitterwerk and ARUP	Hamburg, Germany	√	√	√	√	BIQ House is as a representative case of introducing the latest technology into regenerative buildings.
High Line Park	James Corner Field Operations	New York, USA	√	√	√	√	As a regenerative architecture, the High Line Park has made a huge influence on the three major functions of ecology, recreation and social culture. It proves that as a regenerative architecture, the building users themselves and the impact on surrounding buildings and people must be considered in the design stage.
Ocean's Heaven	CAA	Hulhumalé, Maldive	√	√	√	x	/
Copenhill	BIG	Copenhagen, Denmark	√	√	√	x	/
Bullit centre	Miller Hull	Seattle, USA	√	√	x	√	/
Powerhouse Telemark	Snøhetta	Porsgrunn, Norway	√	√	x	x	/

The selection of the two case studies is based on their similar regenerative building backgrounds and they both have a certain influence in Germany and the United States. Both projects represent the outstanding achievements of their respective countries in regenerative architecture. The world's first bio-adaptive facade is installed in Bio Intelligent Quotient House in Hamburg, Germany. The main material of the bio-adaptive material SolarLeaf is shortlisted for the prestigious Zumtobel award. This project must be a milestone to create a new value chain and plays an important role in establishing surplus energy and zero carbon building clusters for the future. It represents a renewable building by combining the latest biotechnology and construction technology and applying the most cutting-edge technology in architectural design to make it a means of renewable buildings. The New York High Line Park creates a new perspective for examining the city. It is a representative icon of innovative design and regenerative design inspiring significance for landscape design in other cities. It proves to people that regenerative architecture can bring huge changes to the quality of urban life. It represents that regenerative architecture is not only the recycling and utilization of resources for the ecological environment, but also a kind of feedback to the surrounding citizens. In other words, regenerative architecture will also take human mobility into account in the entire design process and consider humanistic factors within the scope of regeneration.

These two projects respectively represent the design paradigms of regenerating usable resources from natural resources and regenerating old buildings. The detailed analysis of the two case studies can provide inspiration and inspiration in the fields of circular architecture and regenerative architecture for professionals such as architects.

2.2.6.1 Bio Intelligent Quotient House in Hamburg

Figure 4 : Bio Intelligent Quotient House [Photograph], courtesy arup/splitterwerk. (2013). Retrieved from https://www.designboom.com/art/worlds-first-algae-powered-building-by-splitterwek/

In Hamburg, Germany, Arup, Strategic Science Consultants (SSC) and Splitterwerk architects have designed the world's first algae-powered architecture (also known as BIQ). Bio Intelligent Quotient House). Both the southeast and southwest sides of the BIQ architecture are double facades, with the inner layer being the architecture's physical exterior and the outer layer being a hollow glass panel containing microalgae.

Figure 5 : "SolarLeaf - The World’s first algae-biomass producing facade system [Photograph], courtesy arup/splitterwerk. (2013). Retrieved from https://www.designboom.com/art/worlds-first-algae-powered-building-by-splitterwek/

In the hollow glass panels, the algae feed on carbon dioxide and nutrients from the pipeline network under sunlight, photosynthesize, and generate heat and biomass energy for the architecture to use renewable energy. If the algae absorb excess heat from the sun, it is used directly to heat water or stored in tanks under architectures for later use. When the algae grow to a certain extent, people can periodically remove a part of the algae and ferment it in an external biogas tank to convert the biomass into biogas, providing heat and electricity for winter combustion. These algae can produce 4,500 kWh of energy per year. The carbon dioxide produced by burning biogas is reused for photosynthesis by algae in the hollow glass panels.

Figure 6 : "The World’s first Solar Leaf-Architecture in Hamburg, Germany [Photograph]; Airlift-System bubbles rising in the Solar Leaf Louvers", courtesy arup/splitterwerk. (2013). Retrieved from https://www.designboom.com/art/worlds-first-algae-powered-building-by-splitterwek/

Figure 7 : Solar Leaf - The World´s first Algae-biomass producing Facade System [Photograph]; Solar Leaf-Louver viewed from Backside with hidden Horizontal Support System. courtesy arup/splitterwerk. (2013). Retrieved from https://www.designboom.com/art/worlds-first-algae-powered-building-by-splitterwek/

In addition to providing energy for the architecture, algae can also provide shelter for the architecture depending on the seasons. The stronger the sunlight, the more vigorous the algae growth, the more shelter provided, and the better the insulation effect, which also greatly reduces the need to use air conditioning. At the same time, algae also have a good effect of sound absorption and noise reduction function.

Using natural materials, BIQ architecture provides sustainable regenerative energy for the architecture, reduces the use of non-regenerative energy, and enables the man-made environment to live in harmony with the natural environment.

Although the technology of using algae as architecture walls is not yet mature and expensive, it cannot be widely used, but this new technology provides a way to create energy for regenerative architectures.

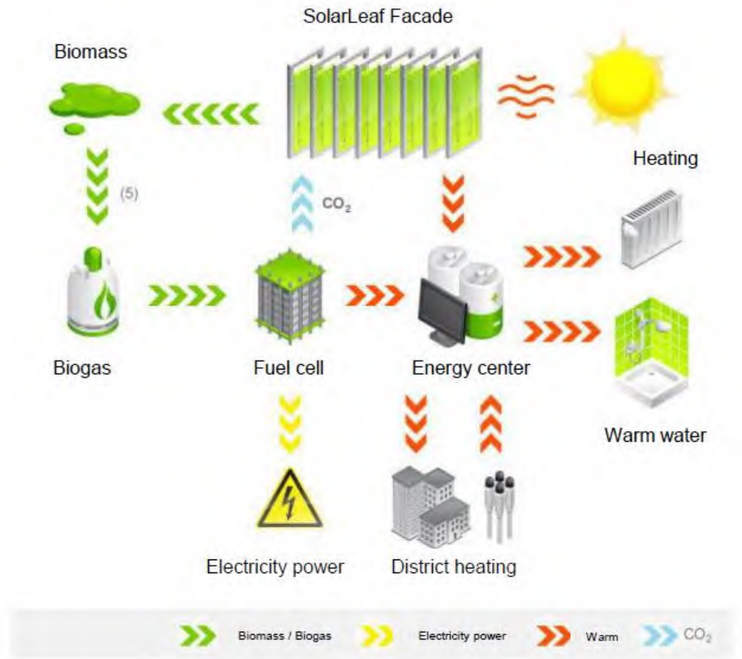


Figure 8: Diagram of the energy flow and operating system, courtesy arup/splitterwerk. (2013). Retrieved from https://www.designboom.com/art/worlds-first-algae-powered-building-by-splitterwek/

Microalgae are the same size as bacteria and can produce more bio-energy per hectare than alternative crops. This cooperation between Splitterwerk Architects, ARUP, Colt International and Strategic Science Consult marks the first time that an algae reactor has been fully integrated into the structure of a building.

2.2.6.2 The High Line Park in New York

The High Line Park is a regenerative design of a discarded，elevated freight-railway that spans 22 blocks through the west side of Manhattan.

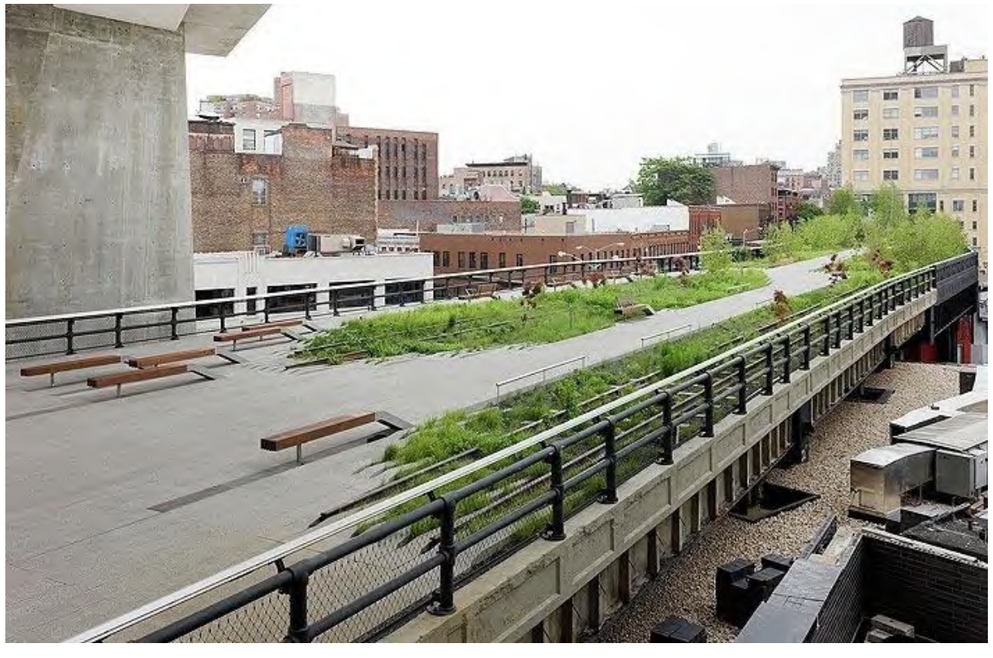


Figure 9 : The New York High Line officially open © Iwan Baan [Photograph] (2009). Retrieved from https://www.archdaily.com/24362/the-new-york-high-line-officially-open

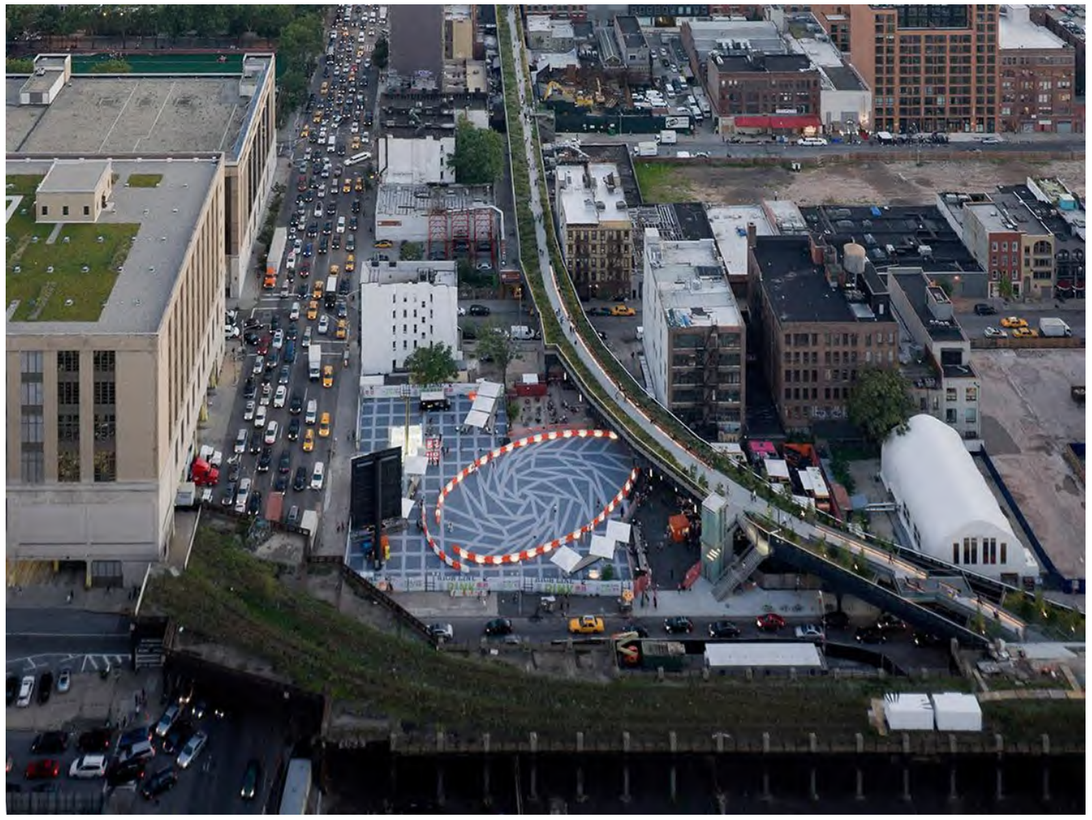


Figure 10 : The High Line Park, New York, 2009, James Corner Field Operations © Iwan Baan [Photograph] (2009). Retrieved from https://www.archdaily.com/24362/the-new-york-high-line-officially-open

New York's Elevated railway has been transformed into a public park and elevated walkway in the Chelsea section of Manhattan, New York City. It was built on an old, elevated freight railroad.

Figure 11: The High Line Park, New York © Iwan Baan [Photograph] (2009). Retrieved from https://landezine.com/high-line-section-2-by-james-corner-field-operations/

Along the concise straight walkway, wildflowers grow freely in the gaps of the original railway tracks; people can enjoy the natural beauty of the green axis stretching towards the city.

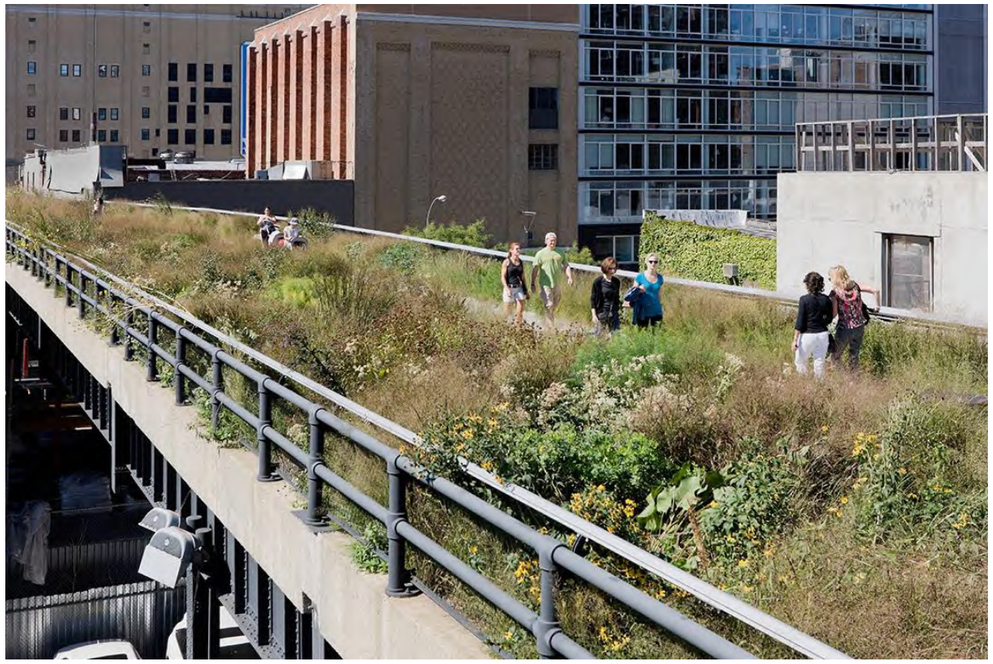


Figure 12: The High Line Park, New York © Iwan Baan [Photograph] (2009). Retrieved from https://landezine.com/high-line-section-2-by-james-corner-field-operations/

The design reflects the High Line's former railway identity through the use of strong industrial materials such as concrete, weathering steel, and recycled wood, and creates a sense of desolation in the abandoned landscape; The selection of grasses and perennials and their layout create a dynamic wild landscape; Old elements such as rails and switches were reinserted; The original structure of special locations, entrances and intersections was preserved and revealed. Standing in the new park, the above points constitute a new interpretation of the project area.

The vegetation, decoration, pavement, lighting, and public facilities of the High Line all belong to the same integrated system, each element of the system plays its own function within a limited width and length, and together constitute a fascinating park landscape.

The pavement is pedestrian-friendly with innovative technology. There are joints in the pavement formed by individual concrete slabs; The edge of the road is deliberately tapered; The land along the road was paved with vegetation and tracks; This allows rainwater to flow freely into the soil layer where the plants are grown, reducing the need for irrigation. Specially designed benches protrude from the pavement to form elegant, cantilevered structures. These benches are used either for viewing the scenery or for chatting.

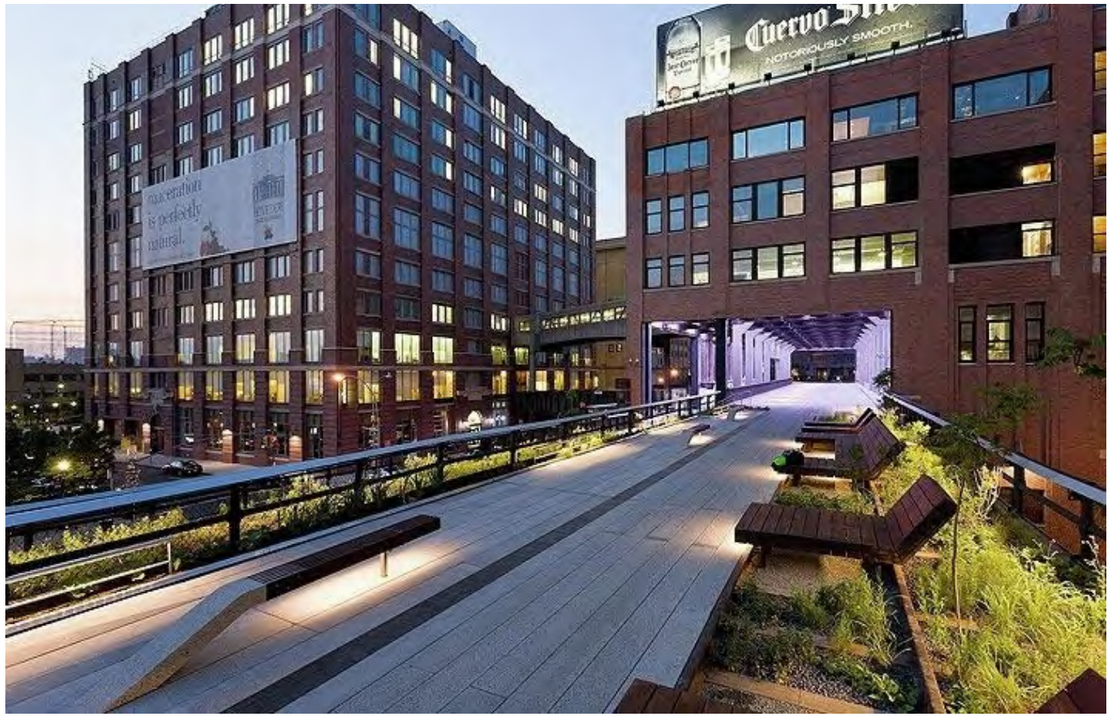


Figure 13 : The High Line Park, New York © Iwan Baan [Photograph] (2009). Retrieved from https://landezine.com/high-line-section-2-by-james-corner-field-operations/

In addition to providing a unique leisure space for visitors, the Elevated Railway Park also has a significant impact on the surrounding community. Since its opening, the park has attracted new businesses, restaurants, and residential developments, making the Chelsea neighborhood a more vibrant and desirable place to live, work and visit. The old railroad, which dates to the 1930s, was used to transport goods along the west side of Manhattan and is part of New York City's larger network of elevated rail lines.

However, as trucking became more popular in the mid-20th century, the use of the line declined, and it was finally abandoned in 1980. Over the years, the elevated structure was unused and fell into disrepair, becoming an eyesore safety hazard. In the late 1990s, a group of residents formed Friends of the High Line in an effort to preserve the disused rail line. In 2002, the city of New York pledged to preserve the structure and transform it into a park.

Wildflowers in the gaps of the tracks bloom in different seasons (from late January to mid-November), bringing a diverse landscape. A wide variety of plants are planted along the High Line Park, creating an ideal habitat for insects and birds and bringing a rich experience to visitors.

The organic combination of abandoned architectures and modern industrial design not only provides a specific growth environment for organic greening in the city, allowing natural rainwater to irrigate green plants, which has a positive long-term impact on the natural environment, but also promotes the vitality of the community. Such regenerative architectures make society, economy and nature get a long-term positive development.

Figure 14: The High Line Park, New York © Iwan Baan [Photograph] (2009). Retrieved from https://landezine.com/high-line-section-2-by-james-corner-field-operations/

03

Status of Chinese Architecture

Chapter Three highlights the current impact of Chinese architecture on the ecological environment, as well as some bottlenecks in the design concepts of Chinese architecture.

China is currently in a period of rapid economic and social development. Forty years is not a long time for architecture itself, but Chinese society has undergone earth-shaking changes. Architectural design concepts must keep pace with these changes. At the same time, the development of society and economy will inevitably lead to a transformation in the demand for architecture, and this transformation also needs to be reflected in the architectural design process.

Moreover, Chinese architecture is currently in the precious transition period of the germination of regenerative architecture.

3.1 Environmental issues caused by Chinese architecture

China is currently in a stage of rapid development. From the 1980s to the present, China's social and economic levels have undergone remarkable changes that have attracted worldwide attention. The tremendous changes brought about in this short span of about 40 years are bound to have an irresistible impact on Chinese architecture. The rapid improvement of social and economic levels will also lead to significant changes in the demand for Chinese architecture. At the same time, China has a vast territory, and differences in economic levels among different regions will also bring about differences in the understanding of architecture. From today's perspective, some buildings in China have excellent design concepts and also introduce the concept of sustainable development in their designs. However, for more Chinese buildings, due to the rapid development of social and economic levels and the differences between regions, the architectural design concepts that lag behind the needs of the times have caused more or less problems to the ecological environment.

3.1.1 Consumption of resources

In the construction process, large amounts of land are occupied. Urban expansion and real estate development often encroach on farmland and forest land, disrupting the natural ecosystem and reducing biodiversity. Additionally, a huge amount of water is needed for activities such as concrete mixing and construction site cleaning. This can put pressure on water resources, especially in areas where water is already scarce. The production of building materials like cement, steel, and wood requires extensive energy and raw materials. For example, cement production consumes large amounts of limestone and coal, and steel production needs iron ore and significant amounts of energy, leading to over-exploitation of natural resources.

3.1.2 Pollution

Construction sites generate a great deal of dust, which not only affects air quality but also poses a threat to people's health. The transportation and storage of building materials can release harmful gases such as volatile organic compounds (VOCs) from paints and coatings. Noise pollution from heavy construction machinery like cranes, mixers, and pile drivers is a common problem, especially in urban areas and near residential areas. Wastewater from construction activities can contaminate surface water and groundwater if not properly treated. Moreover, the large amount of construction waste, including discarded bricks, concrete blocks, and steel, is often improperly disposed of, taking up land and causing environmental pollution.

3.1.3 Energy consumption and carbon emissions

Buildings in China consume a significant amount of energy for heating, cooling, and lighting. Many existing buildings are energy-inefficient, resulting in wasted energy. The entire process of building construction and operation generates a considerable amount of carbon emissions, contributing to climate change.

3.1.4 Urban expansion out of control and deterioration of living environment

The phenomenon of urban expansion spreading the pie is common. Most urban built-up areas adopt a single center expansion model in the form of a pancake. Since 2000, the main urban areas of 17 key cities have expanded by 2-4 times. The ecological regulation function of cities continues to decline, and the "heat island effect" in all major cities across the country is constantly increasing.

Since 2000, the scope of "high-temperature zones" in cities such as Beijing, Tianjin, Shanghai, Guangzhou, Chongqing, and Changsha have significantly increased. 62% of cities in China suffer from urban waterlogging, with 74.6% having a maximum depth of water exceeding 50 centimeters, which has a serious impact on residents' lives. Urban air pollution is severe, and residents' health risks are increasing. The structure of urban green spaces is simple, with a high proportion of exotic plants. For example, in the urban area of Beijing, the proportion of exotic plant species is as high as 52.7%, while the number of wild animal and plant species is small, and the population is low. (Ouyang, 2017)

3.2 The shortcomings existing in Chinese architecture design

The current situation and development of contemporary Chinese architecture, especially for the Chinese architecture design, can be summarized as "three losses": imbalanced value judgments, silence in cross-cultural dialogue, and lack of standardization in institutional construction. (Jianguo, 2019)

3.2.1 Imbalanced value judgments

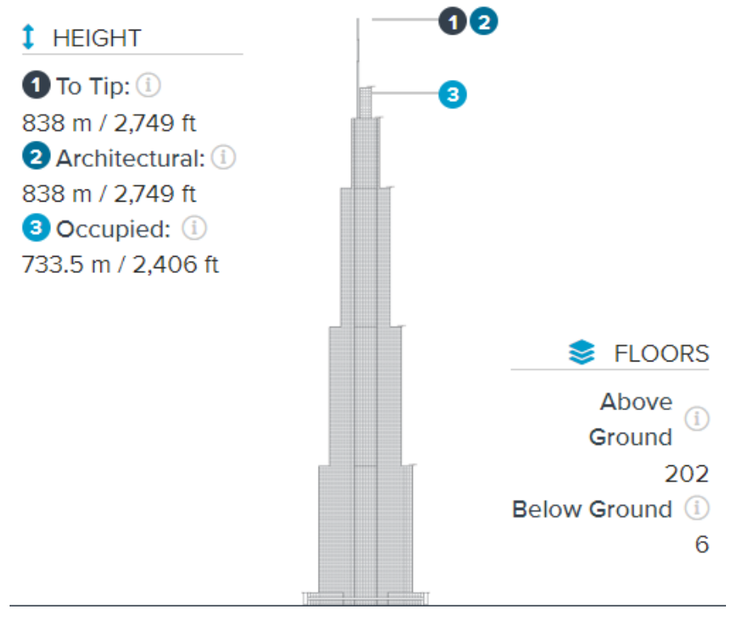


Figure 15 : the Sky City, 838 Meters, Changsha © CTBUH Drawing Retrieved from https://www.skyscrapercenter.com/building/sky-city/14297

A recent example is the planned construction of an 838 meters super tall architecture in Changsha. Why build the world's tallest architecture in a city like Changsha, which has puzzled many people. Is this a requirement of the urban environment, a need for practical functions, or an urgent need for the current development of architecture industrialization? None of them. Especially with the plan to build this super large architecture of 1.05 million square meters in just eight months, it is doubtful what level of completion will be achieved by then. This is just one case. At present, there are many tall unfinished buildings in China. This is a very typical problem in China's architecture field. At the beginning of architectural design and construction, the value of a building is regarded as a landmark, as political achievements, and as an advertising effect. The value of a building is gradually divorced from its own function. This irrational display of skills has caused this architecture to lose its original architectural value and become a giant commercial advertisement. (Cheng, 2014)

3.2.2 The inheritance of traditional culture is out of balance

Unbalance of the inheritance of traditional culture has led to people's enthusiasm for plagiarism and imitation, blindly following the trend. As we have seen, in China, the works of western architects and many imitations that follow the trend are flooding the country, and the lack of "one size fits all" and architectural cultural characteristics has been questioned and criticized by domestic and foreign public opinion.

So even for recycled architectures, it is necessary to explore a development path and underlying logic that is suitable for China itself, and it is impossible to simply copy and paste. If the current situation of cultural silence and architectural rootlessness cannot be changed soon, in thirty or fifty years, China's urbanization process will basically come to an end. At that time, what kind of architecture and urban image will we use to fulfill the dream of "Beautiful China"? How can architecture, as a "history book written in stone," showcase the history of China's rise in the 21st century to our future generations? (Cheng, 2014)

3.2.3 Lack of standardization in institutional construction

To some extent, it can be said that the "power decision-making" that violates the spirit of scientific and democratic decision-making is the root cause of various chaos in the current construction field. For example, the approval of important public architectures in every city often violates the law, and the feasibility study in the early stage of the project has actually become an "approval" study that caters to the leadership. People may ask, how could one city with nine towns, knock off architectures, square architectures, and those architectures that are greedy for size, foreign culture, and ultra-high standards emerge? Why do the phenomenon of "ghost cities" and the heinous cases of large-scale demolition and construction that damage the historical context of cities, which are particularly concerned by public opinion.

The cultural and environmental issues faced by China's environment mentioned above cannot be completely solved solely through regenerative design or the use of systemic thinking in architectural design. However, if China's architecture adopts more systemic design methods to intervene in architectural design, urban design, national infrastructure design, etc. in the future, it will definitely have a positive impact on the cultural and environmental issues faced by Chinese society today.

At present, the Chinese government has also realized the importance of systemic design, also known as recycled architectures, and has launched a series of policies and work plans to actively promote the implementation of systemically designed architectures or similar to recycled architectures. (Cheng, 2014)

3.3 Countermeasures for the issue of Chinese architecture

In response to the current problems of Chinese architecture and Chinese architectural design, the Chinese government has introduced some policies to regulate and improve the problems exposed in the rapid development of China's construction industry. At the same time, in regions with relatively developed economies and generally high levels of public education, there have already been buildings such as green buildings/environmentally friendly buildings. This shows that in these areas, the government, enterprises and the public have begun to realize that architecture, as a part of people's living environment, is closely connected with the natural environment. There have even been cases that can be called renewable buildings, integrating with the local nature, culture and resources. Such buildings should also be publicized and promoted.

3.3.1 Government launched support policies

In 2018, the General Office of the State Council issued the "Work Plan for the Construction Pilot of 'Zero-Waste Cities'" (hereinafter referred to as the "Plan"), proposing to select about 10 cities with appropriate conditions, foundation, and scale across the country to carry out the construction pilot of "Zero-Waste Cities" within the entire city. By 2020, a "Zero-Waste City" construction indicator system was systemically constructed, and comprehensive management and technical systems for the construction of "Zero-Waste Cities" were explored and established, forming several replicable and promotable demonstration models for the construction of "Zero-Waste Cities". The introduction of this plan marked that the development of circular economy in China has entered a new stage. From September 12th to 13th, 2020, the Ministry of Ecology and Environment organized and held the National "Zero-Waste City" Construction Pilot Promotion Conference in Shaoxing City, Zhejiang Province. The construction pilot of "Zero-Waste Cities" has fully entered the crucial stage. (Cao, 2019)

3.3.1.1 Zero-waste City

A "Zero-waste City" does not mean no solid waste is produced, nor does it imply that solid waste can be fully recycled and utilized. Instead, it is an advanced urban management concept, aiming to ultimately achieve the goals of minimizing the generation of solid waste, maximizing resource utilization, and ensuring safe disposal in the entire city through long-term exploration and practice. (Cao, 2019)

A zero-waste city must adhere to the "4 Availability Principles", namely visibility, reducibility, usability, and disposability.

"Visibility" means monitoring the entire process, putting all wastes under supervision, and completely eliminating unorganized emissions of wastes.

"Reducibility" means reducing the amount at the source to alleviate environmental pressure.

"Usability" means recycling wastes through various methods to turn waste into treasure.

"Disposability" means minimizing the environmental impact of the final treatment of wastes to the greatest extent.

3.3.1.2 The meaning of Zero-waste City

China is the country with the largest population and the largest amount of solid waste generation in the world. Every year, about 10 billion tons of new solid waste is produced, and the total historical stockpile is as high as 60 to 70 billion tons. The generation intensity of solid waste is high, and the utilization is insufficient. In some areas, garbage besieging cities and garbage everywhere have become the pain of the people's hearts and the problems of people's livelihood.

A large amount of solid waste has caused the problem of "garbage besieging cities", but it also means that there is great potential for the resource utilization of garbage. Promoting the construction of "zero-waste cities" is of great significance for promoting the source reduction, resource utilization and harmless treatment of solid waste, promoting the green development transformation of cities, improving the quality of the urban ecological environment, and enhancing the livability of cities. (Zhao, 2019)

3.3.1.3 Zero-waste = No garbage?

Zero-waste does not mean generating no garbage at all. Instead, it is a process of continuously reducing the amount of garbage to approach zero through various efforts.

The development of zero-waste is a new model for international economic development and urban and rural construction in recent years. The zero-waste concept, as the main way to achieve the "dual carbon" goals in the field of urban and rural construction, has put forward new requirements and directions for the sustainable development of urban and rural areas. The zero-waste design strategies in the field of landscape architecture include four aspects: scheme design, design technology, material application, and organizational methods. (Cao, 2019)

3.3.2 Regenerative architecture design trend in China

At present, Chinese architecture is still in a stage of rapid development. On the one hand, China's current construction industry is still in a stage of pursuing showy techniques, eye-catching façades, and heights. In many regions, construction enterprises and governments blindly pursue the external design of buildings, lacking systemic thinking. As a result, projects are hastily cancelled, wasting a large amount of resources, manpower, and material resources. On the other hand, in some economically developed regions where people are also well-educated, the government and local enterprises are also responding to the government's call for green buildings and beginning to think about the relationship between architecture and the environment, and between architecture and humanity.

In short, in these areas, regenerative architecture has already begun to developing. For example, the SAIC Volkswagen Zero Impact Factory. To some extent, some buildings or facilities have introduced some concepts of systemic design at the very beginning of their design, such as the Yixing Water Resource Recovery Factory.

3.4 SAIC Volkswagen (SVW)

Zero-impact factory

SAIC Volkswagen AUTOMOTIVE CO., LTD. (SAIC Volkswagen) is a joint venture founded by SAIC Motor from China and Volkswagen Group from Germany, each holding a 50% stake. SAIC Volkswagen, headquartered in Shanghai, was founded in October 1984 and has since established production bases in Shanghai, Jiangsu, Xinjiang, Zhejiang, Hunan, and other places, with a total production and sales exceeding 28 million vehicles and employing over 26,000 people.

The Anting MEB (Modularer E-Antriebs-Baukasten) factory of SAIC Volkswagen is the world's first factory newly built by Volkswagen specifically for the production of MEB platform models. With a total investment of over 17 billion yuan, it extensively applies renewable energy and is a green factory that reduces carbon in all aspects. At the same time, the Anting MEB factory has fully realized refined management, which benefits from the application of highly digitalized and intelligent technologies.

Figure 16 : “Way to Zero” and “Decarbonization” Poster in SAIC Volkswagen

Figure 17 : SAIC Volkswagen MEB factory [Photograph] (2022) Retrieved from https://www.csvw.com/csvw-website/news/company-news.html?newsid=3342

In the MEB factory, SAIC Volkswagen implements the " Way to Zero " concept of the Volkswagen Group, utilizes intelligent management systems and multiple environmental protection technologies, and brings "Zero-Impact" pure electric vehicles to consumers with a "zero-impact" factory. And in SAIC Volkswagen, the enterprise has also vigorously publicized Way to Zero and related contents.

" Way to Zero " means that Volkswagen will introduce relevant green and sustainable concepts at the beginning of the design and construction of the factory. Through systemic design methods, it is ensured that by 2030, Volkswagen Group (China) will use 100% renewable or clean electricity in the production field.

At the same time, relying on three major measures of energy supply partnerships, self-produced renewable energy, and energy conservation and consumption reduction,

Volkswagen Group (China) continues to promote carbon emission reduction in the production field and contributes to the realization of China's "dual carbon" goals, aiming to achieve net zero carbon neutrality by 2050. The carbon dioxide emissions per car have dropped by 60%.

3.4.1 Environmentally friendly factory

Based on the " Way to Zero " carbon emission reduction strategy of the Volkswagen Group, SAIC Volkswagen's MEB factory has been actively practicing green production from the very beginning of planning to its completion what be called systemic design, ensuring the investment in energy-saving technologies, continuously optimizing environmental protection measures, and striving to achieve the vision of a "zero-impact" factory.

During the systemic design stage of the factory, special attention was paid to the intensive use of land. Its floor area is only one-third of that of other factories of the same scale. It is worth mentioning that the factory also has the largest 120JPH paint shop of the Volkswagen Group globally. Its production capacity is twice that of a standardized paint shop, which can save 10% of energy consumption while saving land.

Figure 18 : SAIC Volkswagen MEB factory Overview [Photograph] (2022) Retrieved from https://www.csvw.com/csvw website/news/company-news.html?newsid=3342

Meanwhile, the MEB factory has invested in a total of 28 advanced environmental protection technologies, including volatile organic compound (VOC) purification systems, 100% direct purchase of hydropower, reclaimed water reuse, and combined heat and power supply. These measures have reduced five key environmental indicators including energy, water, carbon dioxide, volatile organic compounds, and waste by 20%. Take the combined heat and power supply technology as an example. While using natural gas for power supply, the steam generated from the waste heat is used for heating, achieving stepwise utilization of natural energy, and significantly reducing greenhouse gas emissions such as carbon dioxide, with an annual carbon reduction of 12,000 tons. Through measures such as 100% purchase of hydropower, installation of solar photovoltaic power generation equipment, and exploration of wind energy applications, the carbon dioxide emissions per vehicle have effectively decreased by 60%.

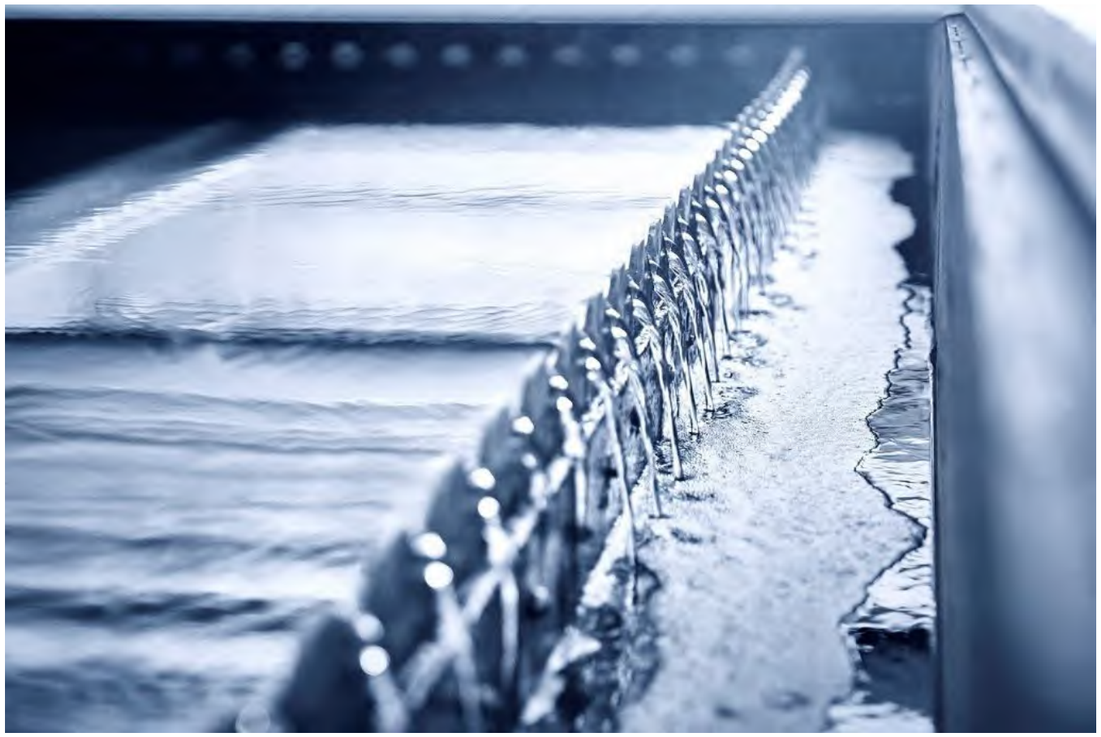


Figure 19 : The combined heat and power supply technology – Steam heater [Photograph] (2022) Retrieved from https://www.csvw.com/csvw/news/company-news.html?newsid=3342

With a series of practices in the field of green environmental protection, the MEB factory has also obtained the highest-level green architecture label issued by the < Ministry of Housing and Urban-Rural Development of the People's Republic of China >, becoming an environmentally friendly and high-quality architecture with authoritative certification.

3.4.2 Intelligent management system

As the benchmark of "Industry 4.0" intelligent manufacturing for SAIC Volkswagen's new energy vehicle factory, digital and intelligent technologies not only contribute to efficient production and manufacturing, but also play a significant role in the field of energy conservation and emission reduction.

The factory has four core intelligent management systems: the Central Monitoring System, the Intelligent Equipment Management System, the Intelligent Production Management System, and the Intelligent Energy Management System. Among them, the Intelligent Energy Management System is precisely the "butler" responsible for the factory's green production. Through the intelligent meters installed on energy-consuming equipment, the system will conduct real-time monitoring and analysis of the factory's emissions and energy consumption data for five major energy types and set up an alarm mechanism for excessive energy consumption; meanwhile, this system can also continuously learn and take the initiative by using big data and cloud computing methods. It can not only predict the energy consumption of the workshop, issue early warnings for possible excessive energy consumption, but also provide optimization plans for energy consumption and production capacity scheduling, helping the factory explore the optimal strategy for energy conservation and emission reduction.

Figure 20 : the Intelligent Energy Management System in the Production Line [Photograph] (2022) Retrieved from https://www.csvw.com/csvw-website/news/company-news.html?newsid=3342

In the production line process, the new energy vehicle factory also adopts a number of more environmentally friendly processes to further improve the level of energy conservation and emission reduction. For example, the workshop replaces traditional gas servo welding guns with electric servo welding guns, and replaces 12Bar compressed air with electric energy, which can save 70% of energy consumption. In the paint shop, SAIC Volkswagen replaces the circulating water system with a Venturi dry paint mist absorption system, which not only reduces resource loss by 60%, but also no longer uses chemical agents to eliminate the generation of harmful waste. The intelligent drying room

technology can intelligently adjust the power of the combustion furnace according to the number of vehicles in the drying room to reduce the actual fuel consumption.

In addition to achieving environmentally friendly manufacturing and products, SAIC Volkswagen also attaches importance to the further improvement of the production environment. In the stamping workshop, SAIC Volkswagen covers the presses with overall sound insulation covers and adopts internal mesh plate sound insulation technology in the waste recycling room, effectively reducing workshop noise and creating a quieter and healthier working environment for employees.

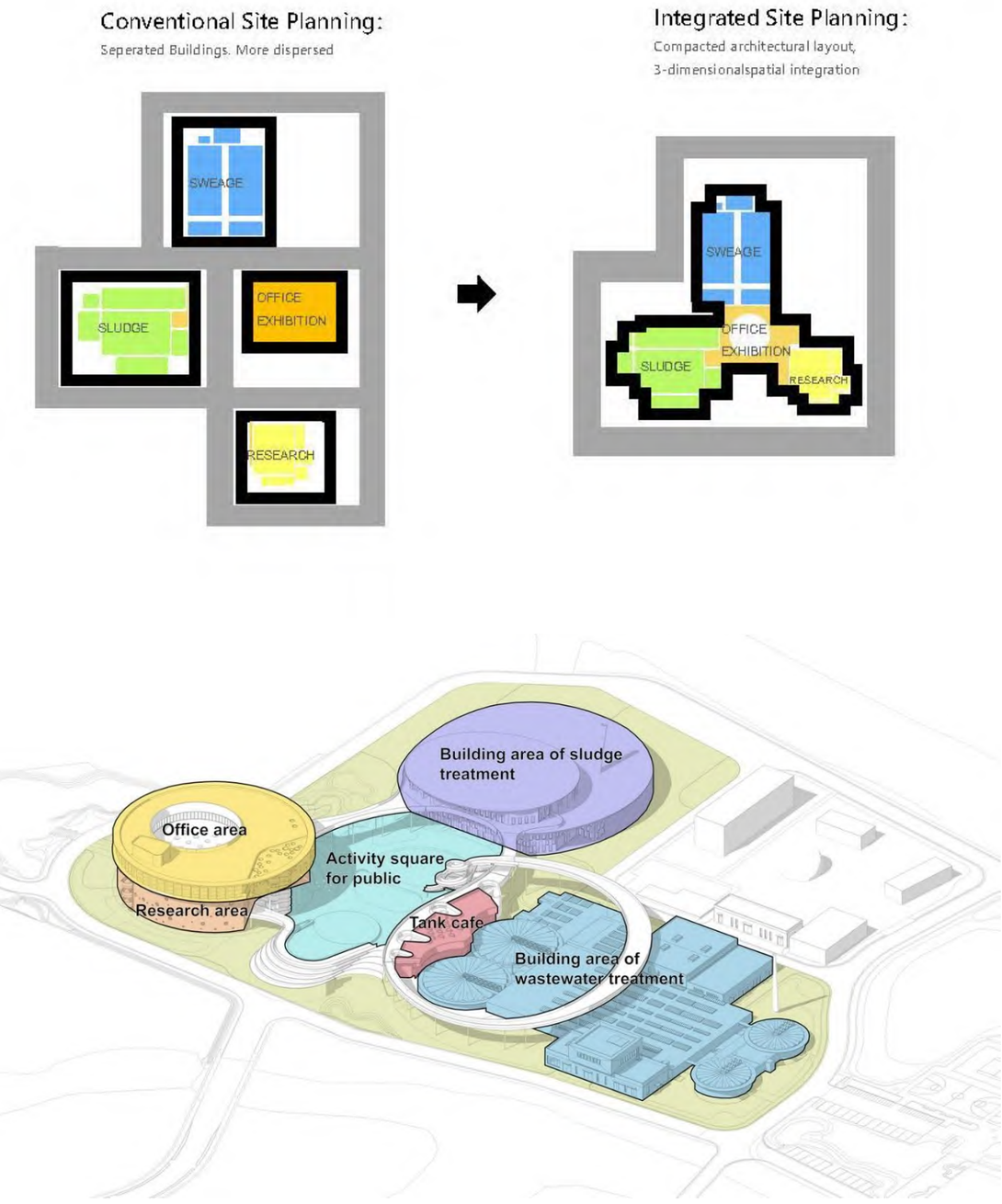
In the new energy vehicle factory, the investment in intelligent technology and environmental protection technology has fully integrated energy conservation and emission reduction and the concept of sustainable development into all aspects of production, logistics and products, achieving green and low-carbon operations. In the future, multiple brands, and several pure electric products of the MEB platform will successively roll off the assembly line here, truly benefiting consumers with convenient and environmentally friendly pure electric travel.

3.5 Yixing Water Resource Recovery Factory

Figure 21 : Yixing Water Resource Recovery Facility © Xiazhi [Photograph] (2021) Retrieved from https://www.archdaily.cn/cn/1010916/yi-xing-cheng-shi-wu-shui-zi-yuan-gai-nian-han-qing-hua-yuan-su-po-gong-zuo-shi

Yixing Water Resource Recovery Facility is an important practical project that upgrades traditional sewage treatment plants into resource recycling factories. It also reduces the not-in-my-back-yard effect of sewage treatment plants, transforming traditional closed pollution treatment factories into environmentally friendly, publicly accessible, integrated into the environment, for science popularization and education, and future-oriented infrastructure. It is also an upgrade of traditional pollution treatment factories into ecologically friendly and resource-recycling modern concept factories.

Four pursuits of the concept plant is be considered as the main characteristic: "Perpetual water quality, self-sufficient energy, resource recycling, and environmental friendliness". The overall construction of the concept plant includes sewage treatment, sludge and organic matter treatment centers, scientific management centers, pilot-scale test areas of experimental lines, and other contents.



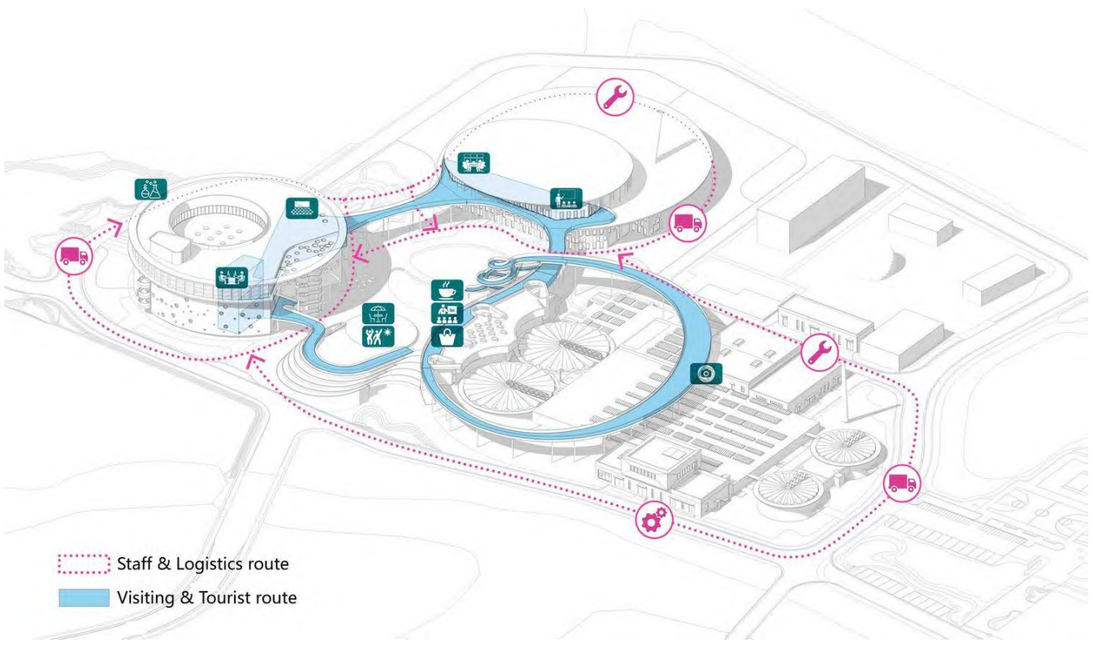


Figure 22 : The regional division of the Yixing Municipal Pollution Resource Concept Plant © Xiazhi [Photograph] (2021) Retrieved from https://www.archdaily.cn/cn/1010916/yi-xing-cheng-shi-wu-shui-zi-yuan-gai-nian-han-qing-hua-yuan-su-po-gong-zuo-shi

The entire region is divided into three groups: the water area on the north side (sewage treatment), the sludge area on the west side (sludge and organic matter treatment), and the R&D office area on the southeast side. Each of the three groups has its own independent entrance and exit and front yard space. The visiting connecting bridges surrounding the shared water garden landscape in the middle serve as a link to connect the three scattered units into a whole. The setting of the connecting bridges not only enables people to understand the sewage resource plant from a more three-dimensional perspective, but also separates the three groups spatially to avoid mutual interference and achieve the integration of architecture and landscape.

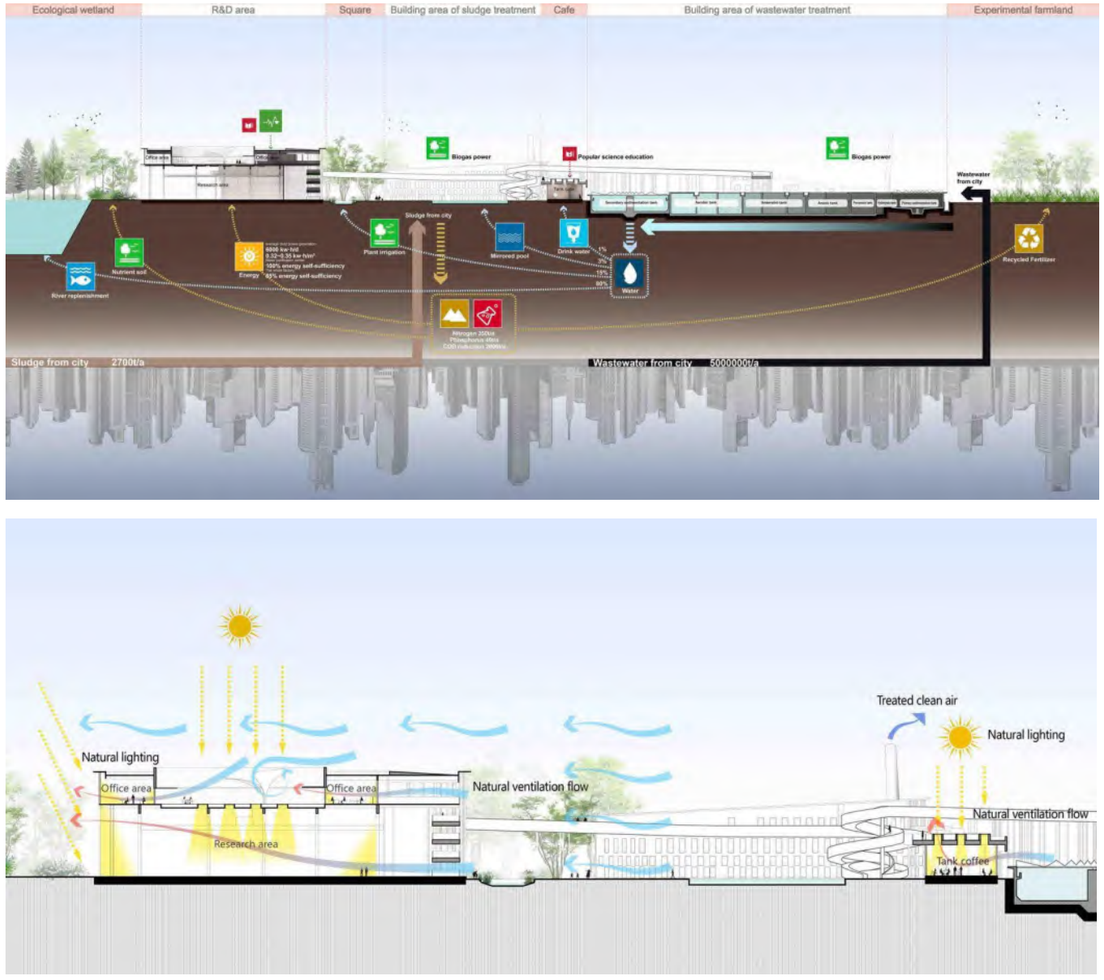


Figure 23 : The circulation routes of the Yixing Water Resource Recovery Facility ©SUP Atelier of THAD Retrieved from https://www.archiposition.com/items/20231129031928

Take the sewage treatment area as an example. The finishing touch in the water area is the linear sequential space of Pool Coffee and the central control exhibition hall close to the south side of the secondary sedimentation tank. This part not only fits seamlessly with the structure of the secondary sedimentation tank, but is also an integrated design treatment of architecture, landscape, interior, and lighting.

Figure 24 : Pool Coffee center of Yixing Water Resource Recovery Facility © Xiazhi [Photograph] (2021) Retrieved from https://www.archdaily.cn/cn/1010916/yi-xing-cheng-shi-wu-shui-zi-yuan-gai-nian-han-qing-hua-yuan-su-po-gong-zuo-shi

Figure 25 : The integrated design of skylight and lighting for Pool Coffee of Yixing Water Resource Recovery Facility © Xiazhi [Photograph] (2021) Retrieved from https://www.archdaily.cn/cn/1010916/yi-xing-cheng-shi-wu-shui-zi-yuan-gai-nian-han-qing-hua-yuan-su-po-gong-zuo-shi

The interior of the coffee area has a column-free overall space that is transparent from north to south. With the multi-functional layout at different times, it can meet various usage modes such as science popularization classes, academic forums, and buffets. Considering various usage scenarios, the place temperament of the coffee area needs to be both elegant and decent as well as friendly and interesting. Therefore, functional elements such as skylights, lighting fixtures, and air conditioning vents are all precisely positioned and designed to create the visual aesthetics of the interior, striving to achieve "decoration without decoration". In addition, the uniform arrangement of the circular skylights on the roof enables the coffee shop to rely entirely on natural lighting during the

day without turning on the lights. The circular membrane lamps arranged at intervals with the exact same diameter as the skylights and the circular lamps hidden at the top of the circular skylights achieve different but harmonious lighting effects at night and during the day. To improve the natural ventilation in the coffee shop, three skylights are treated as high side windows that can be opened from the side, reducing reliance on air conditioning and energy consumption while improving indoor comfort. The spatial aesthetics of the interior and the sustainable design principle of energy conservation and carbon reduction are integrated here.

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The planning of the factory area focuses on four points: efficient layout and intensive land use; transforming the traditional waste treatment into a resource recycling factory; integrated design of landscape and architecture; and all-round sustainability in terms of "Environment, Society, and Humanity".

3.6 Conclusion

Admittedly, there are many problems existing in Chinese architecture at present, especially in terms of architectural values. However, it is undeniable that at present in China, there are also some opportunities suitable for the development of regenerative architecture, or what can be called the trends of regenerative architecture.

In the above two systemic design cases, the environment and ecology, the factory and nature, as well as human factors, have all formed a balanced situation very well. The combination of organic and inorganic substances, the architecture itself and its surrounding environment, as well as the people using the architecture, have all achieved natural harmony. The final architectural works presented are all impressive.

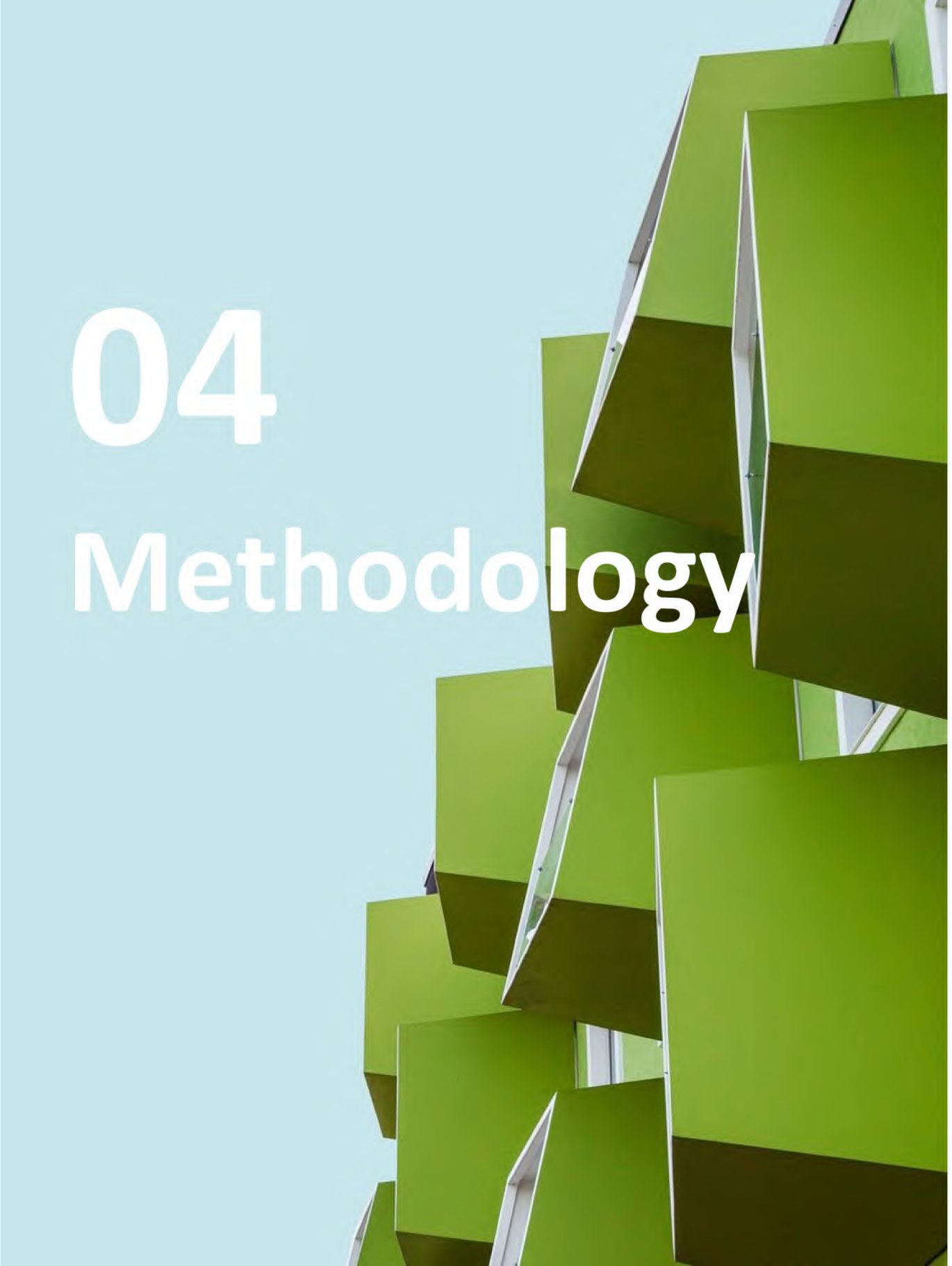
It can be said that the current Chinese architectural industry has begun to realize the importance of systemic design and has achieved certain results. However, the current scope of implementation is relatively limited. This article will take the SAIC Volkswagen Integrated Management Building as the instance to introduce systemic design into the regeneration and optimization of existing architectures. This can be somewhat referential for Chinese architecture. From the perspective of systemic design itself, the optimal solution is definitely to introduce systemic design from the very beginning of the design. However, for the current situation of Chinese architecture, the optimization and transformation of existing architectures is a more universal solution.

Table 3 : Chinese architecture cases overview

	Case two: SAIC Volkswagen Zero-Impact Factory	Case one: Yixing Water Resource Recovery Factory
Green/high performance design - Relative improvement (environmental rating toots etc)	√	√
Sustainable design - Neutral -"100% loss bad" (McDonough)	√	√
Regenerative design - Humans intentionally participate as nature - actively co-evolving the whole system	Pending upgrade	√

In the above two systemic design cases, the environment and ecology, the factory and nature, as well as human factors, have all formed a balanced situation very well. The combination of organic and inorganic substances, the architecture itself and its surrounding environment, as well as the people using the architecture, have all achieved natural harmony. The final architectural works presented are all impressive.

It can be said that the current Chinese architectural industry has begun to realize the importance of systemic design and has achieved certain results. However, the current scope of implementation is relatively limited. This article will take the SAIC Volkswagen Integrated Management Building as the instance to introduce systemic design into the regeneration and optimization of existing architectures. This can be somewhat referential for Chinese architecture. From the perspective of systemic design itself, the optimal solution is definitely to introduce systemic design from the very beginning of the design. However, for the current situation of Chinese architecture, the optimization and transformation of existing architectures is a more universal solution.



04

Methodology

Chapter Four focuses on elucidating the methodology of this paper, namely the 5P principles of systemic design (Principle, Place, People, Process, Practice).

4.1 Systemic design practice framework

In the field of architectural design, one of the main problems that design faces is the lack of a systemic methodology regarding environmental sustainability. According to (Bistagnino, 2011), Systemic Design also brings about “a change in the approach to the output of the production systems”, turning it from a problem into a resource (new input for another system). Therefore, a systemic approach can help designers to face complex issues, considering both users (human-centered design) and environment (principle of outputs> inputs) (Barbero, et al., 2017). The discipline of systemic design integrates systemic thinking and follows human-centered design principles. By applying systemic thinking and human-centered design principles to design tasks, we can intervene in the entire life cycle of the system. The characteristic of systemic design that is particularly suitable for managing complex systems determines the inevitability of using system design as a methodology.

For the systemic design, we need a tool to help us to conduct systemic thinking. The Systemic Design Practice Wheel provides a tool for workshop design and engagement. These cover the key considerations for people working with communities and stakeholders on shared challenges. (Blomkamp, 2020)

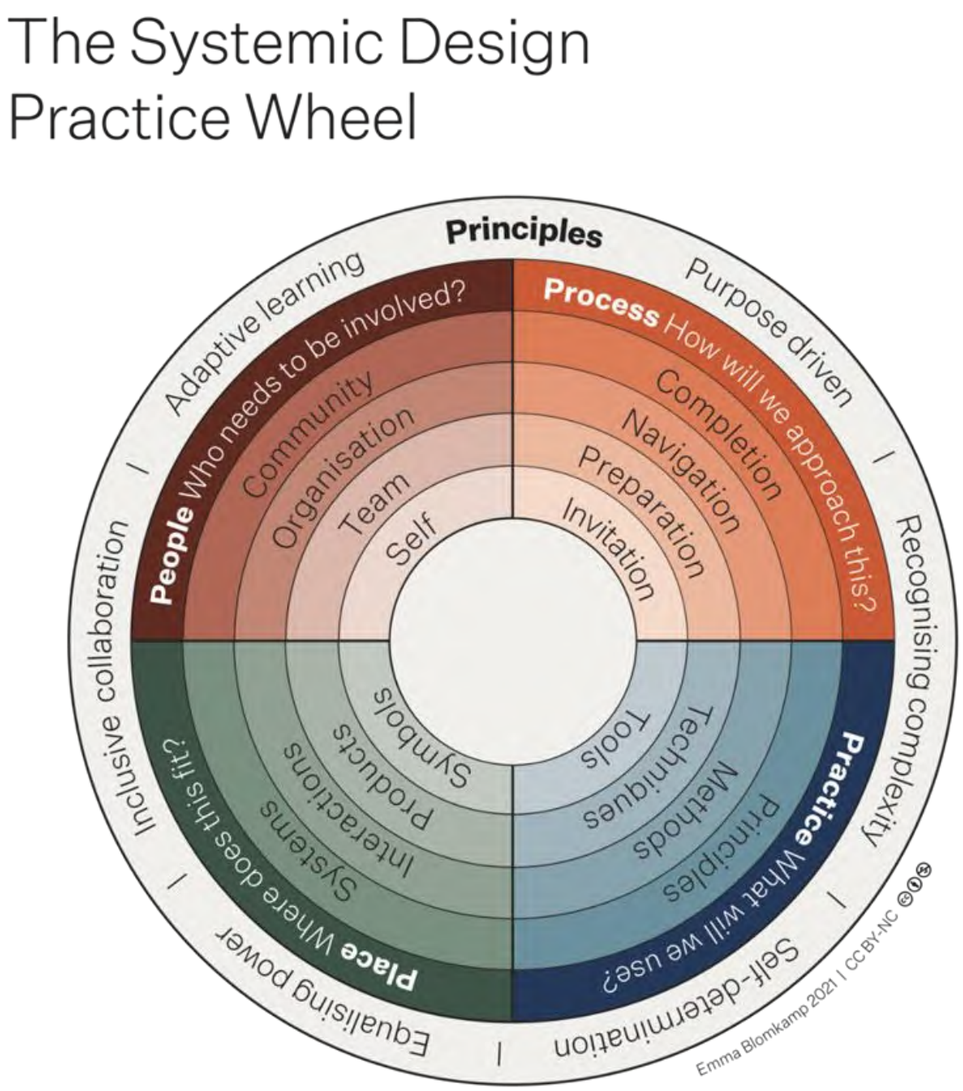


Figure 26 : The Systemic Design Practice Wheel (Blomkamp, 2020)

The Systemic Design Practice Wheel was designed by Emma Blomkamp. Its design principle mainly extracts experience and knowledge from research, evaluation, education and practice in public and social innovation design, providing creative and participatory methodological guidance for practitioners to deal with complex problems. It may be based on the following concepts:

On the one hand, it emphasizes systemic thinking about complex problems. Recognizing that problems are often in complex systems, multiple factors and stakeholders need to be considered comprehensively, and problems are analyzed and solved from an overall perspective.

On the other hand, it focuses on creativity and participation. It encourages practitioners to adopt innovative methods to stimulate creativity. At the same time, it emphasizes the participation of stakeholders to jointly explore solutions to achieve more sustainable and socially valuable design results.

The Systemic Design Practice Wheel has five core parts: principles, place, process, people, and practice (as shown in *Figure 26*):

Principles: Why and how does the systemic design work?

Place: Where does this fit?

People: Who needs to be involved?

Process: How will we approach?

Practice: What will we use?

4.1.1 Principle

The principles are the values and core instructions to advise people on systemic design for the Objects.

The 5P framework, as the basis, explains very specifically how to conduct systemic analysis from the source for a design object, to achieve the purpose of systemic design.

Purpose-driven

What are our objectives/goals and desired outcomes? Why is this work important? (Blomkamp, 2020)

At the beginning, for the systemic design, the purpose of the design work must be clarified. A clear purpose makes the work achievable and efficient.

Recognizing complexity

How are we recognizing and responding to the dynamic and interconnected nature of complex problems and systems? (Blomkamp, 2020)

Systemic design is founded on the recognition of complex adaptive systems, which have features such as self-organization, feedback loops and emergence.

Self-determination

How are we respecting individual agency, rights, and strengths? How are we supporting community-led action? (Blomkamp, 2020)

This also means that designers should not only design from their own perspective, but also incorporate the design object into the entire environment and incorporate the users of the design object into the scope of thinking.

Equalizing power

Whose voices and ideas are usually privileged and why? How might we rebalance power, distribute leadership and share decision-making? (Blomkamp, 2020)

As a member of the system, whether it is human beings, the ecological environment, the architecture itself, etc., will be reasonable and equal thinking and design, and each role should be treated fairly, which is the significance of system design.

Inclusive collaboration

How can we best engage diverse participants? What conditions and resources are required for collaboration? (Blomkamp, 2020)

Similarly, every role in the system needs to cooperate, whether it is the user, the designer, etc., which is more demanding for the designer. Similarly, every role in the system needs to cooperate, whether it is the user, the designer, etc., which is more demanding for the designer.

Adaptive learning

When and how will our activities and outputs be tested, evaluated, and iterated? (Blomkamp, 2020)

The adaptation of the system and the feedback of the system to the roles within the system also need to be taken into account from the perspective of systemic design. It's a circular process.

4.1.2 Place

Place can be more accurately described as the background of the design object, the system environment in which the design object is located, the interaction or feedback between the system environment and the design object, and the design object itself, even the characteristics of the design object, can all be classified into this category. After confirming the design goal, only the background of the design object itself is analyzed in detail, in order to complete a very targeted system design with its own system characteristics.

Systems: Which environment/s, sector/s and system/s is this work situated within and seeking to change? What is the political, historical, and sociocultural context?

Interactions: What relationships, initiatives or services might we change or create? What will people's experience be like? How does this connect with other objects, activities, organizations, and networks?

Products: What objects or artefacts might we create, for whom, and how will they be used?

Symbols: What visual language or brand guidelines will we use or create? How will we communicate about our work? (Blomkamp, 2020)

4.1.3 People

Self: What is my position in this work and this system?

Team: What roles and skills do we need? How will we support them/each other?

Organization: What resources, expectations and requirements do the organizations involved have?

Community: Who will this impact? How and when will they be engaged in the work?

And also, the people here should not only refer to the designers themselves, users, investors, and even people indirectly related to the design object should be considered. All these people more or less have an impact on the final outcome of the design object, and the systemic design itself requires that all of these objects related to the system be taken into account for analysis and design. (Blomkamp, 2020)

4.1.4 Process

Invitation: Is co-design right for us, right now?

Preparation: What approach will we take? What conditions, capabilities, relationships, and resources do we need?

Navigation: How and when can we care for, coordinate, and communicate with the people interested and involved?

Completion: With whom and how will we close the loop, keep in touch, and share outputs and learnings? (Blomkamp, 2020)

Systemic design practice typically follows an innovation process. In systemic design, the design process is often difficult to control, but if there is no process, there is no design result. Therefore, after the systemic analysis in the early stage, the design process is often the top priority of the design. Designers need to carry out orderly and creative design according to the three elements mentioned above, namely, principle, place and people. Although the process is uncontrollable, it is also full of innovation.

4.1.5 Practice

Tools: What materials or instruments might be useful for this technique or method?

Techniques: What activities, tasks, tactics, or techniques will help us achieve our objectives? What skills are required to use the tools?

Methods: Which method, strategy, procedure, or approach might we adopt? How will we build capability in these methods?

Principles: How will each principle guide our approach? (Blomkamp, 2020)

The results of systemic design, or practice, are the embodiment of the principles of design and the control of the design process, and the design results presented by practical means, methods, and technologies. In systemic design, it is often necessary to consider the practical factors in the design process, so that the final design results can fully achieve the design goal.

The 5P framework in regenerative design for SAIC Volkswagen integrated management building

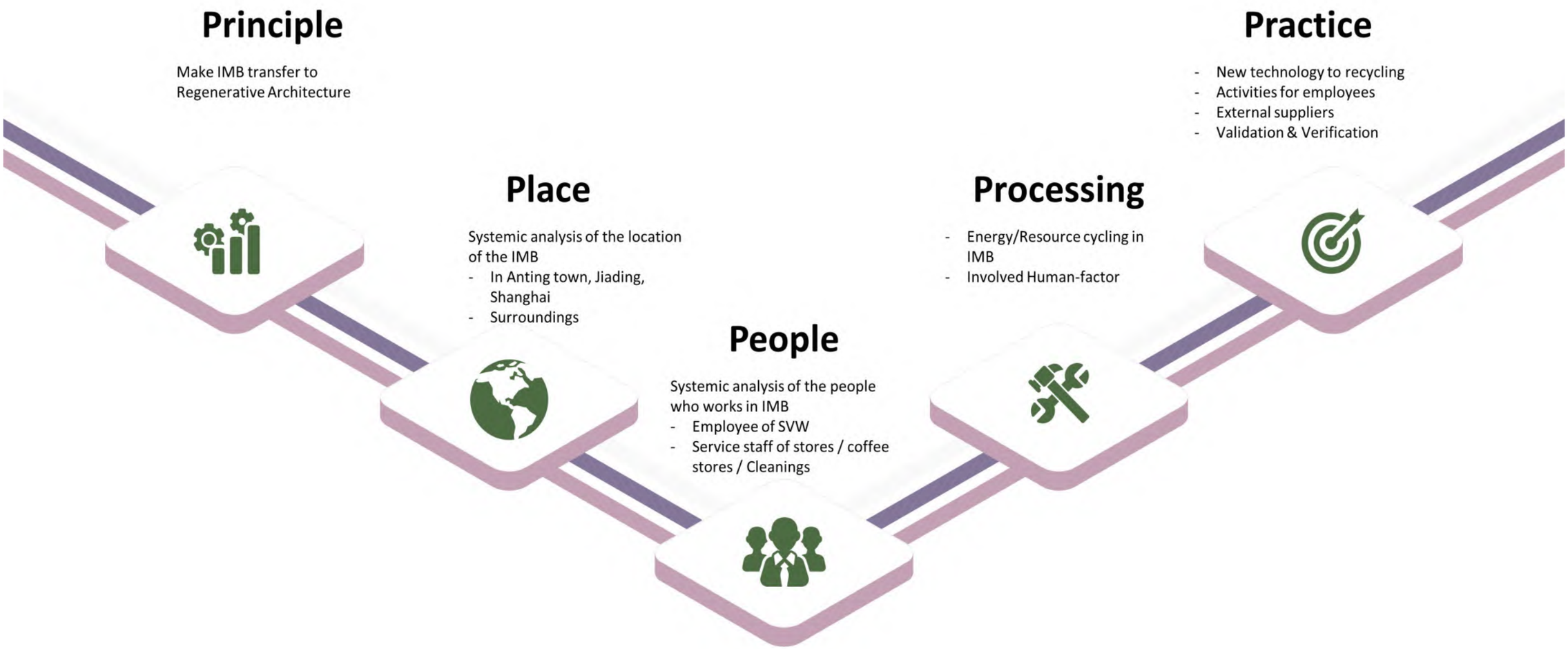


Figure 27 : The 5P framework in regenerative design for SAIC Volkswagen IMB

05

Systemic Design for Regenerative Architecture for Saic Volkswagen

Chapter Five is the focal point of this paper and represents the practical segment. It elaborates on the entire design and implementation process for the SVW Integrated Managenment Buidling regenerative project, from the analysis through the thinking of systemic design to the final execution of the systemic design.

By leveraging the Place and People factors within the 5P framework and integrating the Principle, an appropriate Process is identified, and ultimately, the entire renovation process is implemented through Practice.

Additionally, the regenerative process is validated by analyzing vernacular architecture against the nine principles of regenerative architecture as outlined by Littman (2009).

5.1 Systemic design analysis for regenerative architecture – SAIC Volkswagen Integrated Management Building (SVW IMB)

5.1.1 Shanghai and SAIC Volkswagen

Shanghai is China's economic center and an international metropolis. The automobile industry plays an extremely important role in its economic development. According to the Statistics of Shanghai Automobile Sales Industry Association, in 2023, Shanghai's automobile manufacturing industry completed operating income of 960.301 billion yuan, a year-on-year increase of 9.4%; realized total profits of 37.012 billion yuan, an increase of 21.1%. The booming development of the automobile industry not only brings huge economic benefits to Shanghai but also enhances Shanghai's industrial level and international influence and promotes the research and development and innovation of related technologies.

In Shanghai's automobile industry pattern, SAIC Volkswagen holds a pivotal position. SAIC Volkswagen has three production bases in Anting Town, Jiading District, Shanghai, mainly producing models of brands such as Volkswagen, Skoda, and Audi. Its production capacity and output occupy an important share in Shanghai's automobile industry. In 2023, it produced more than 450,000 vehicles, making important contributions to the development of Shanghai's automobile industry. At the same time, the development of SAIC Volkswagen has also driven the development of automobile parts enterprises in surrounding areas of Shanghai, forming a huge automobile industry cluster and playing a key role in the improvement and upgrading of Shanghai's automobile industry chain.

Jiading District is the northwest gateway of Shanghai. The automobile industry is its most representative and competitive core advantage. Jiading District occupies "half of the country" in the overall situation of the city's automobile industry, and SAIC Volkswagen occupies "half of the country" of Jiading's automobiles. As the oldest and largest production base and production and research and development headquarters of SAIC Volkswagen, SAIC Volkswagen is closely connected with Jiading. Since SAIC Volkswagen settled in Anting in 1984, it has become an important support for the economic and social development of Jiading. The existence of SAIC Volkswagen has attracted a large number of automobile-related enterprises and professionals to gather in Jiading. The district has seven national-level public service platforms in the automobile field and more than 20,000 automobile professionals. It plays an irreplaceable role in Jiading District's industrial upgrading, employment drive, economic growth, and urban brand building, laying a solid foundation for Jiading to build a world-class automobile industry center.

Table 4： Information of several automotive enterprises in Jiading District

Automotive enterprise in Jiading	Headquarter of China/Asia in Jiading	R&D center in Jiading	Factory in Jiading
SAIC Volkswagen	√	√	√
Volvo Car (Asia Pacific)	√	√	
NIO	√	√	
SAIC Motor	√	√	
Schaeffler	√	√	
ZF			√
Aptiv			√
Bosch			√

According to the systemic design practice wheel, before starting the design for the architecture, we particularly need to accurately define and understand people and place in the 5P. For the regeneration of Integrated Management Building, we must consider the original location of Integrated Management Building, its o
on the surrounding environment, etc. And for Integrate
the most important elements, or people, is the employee
Management Building.

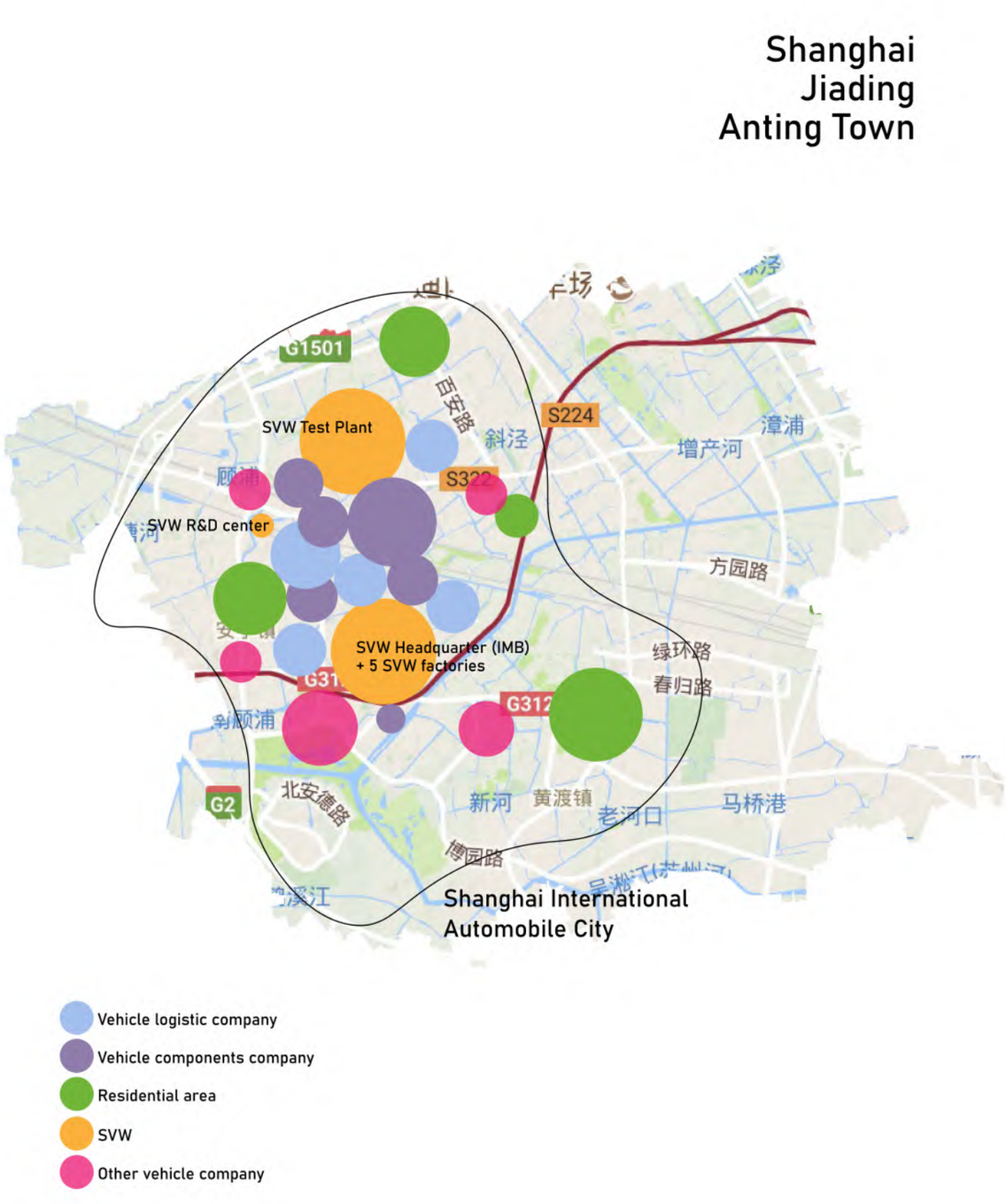
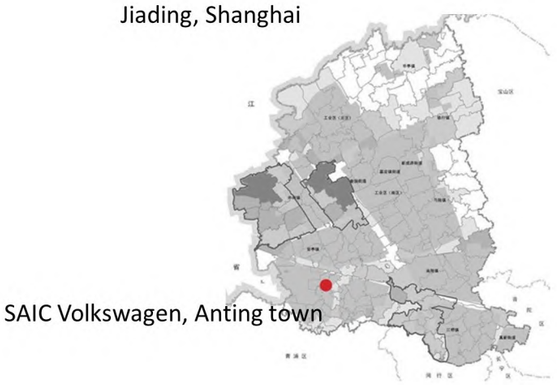


Figure 28 : Location of SAIC Volkswagen in Anting town, Jiading District, Shanghai

5.1.2 Place of SAIC Volkswagen Integrated Management Building (SVW IMB)



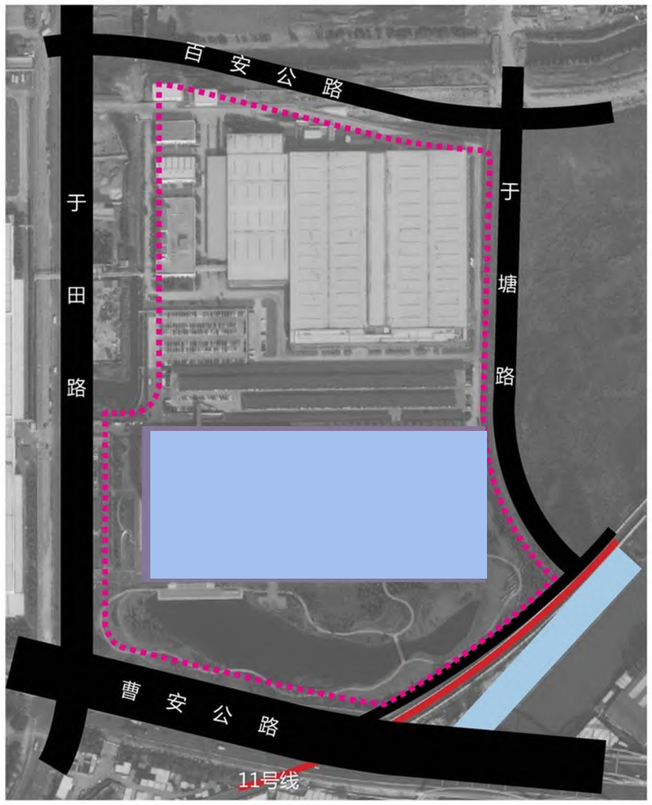


Figure 29 : The location schematic diagram of the SAIC Volkswagen Integrated Management Building. Retrieved from https://www.archdaily.cn/cn/950606/shang-qi-da-zhong-qi-che-you-xian-gong-si-ji-zhu-guan-li-zhong-xin-er-qi-b-plus-h-architects

The project everywhere demonstrates the vision of this world-leading automotive manufacturer - promoting innovation, fostering a collaborative culture, attracting top global talents, and establishing close connections with the local community. The Integrated Management Building of the SAIC Volkswagen has created the most advanced office spaces, meeting rooms, training centers, event venues and staff restaurants for employees.

Figure 30 : SAIC Volkswagen Integrated Management Building Overview [Photograph].
Retrieved from https://www.archdaily.cn/cn/950606/shang-qi-da-zhong-qi-che-you-xian-gong-si-ji-zhu-guan-li-zhong-xin-er-qi-b-plus-h-architects

SAIC Volkswagen Integrated Management Building is divided into two parts, Phase I and Phase II. The façade designs of both Phase I and Phase II architectures adopt an elegant and simple modern style. The use of horizontal aluminum plate lines symbolizes a sense of speed. In terms of shape processing, the inclined plane designs at both ends and the visual elements of wide at the top and narrow at the bottom echo the logo of Volkswagen. Through spacious space planning and the use of sustainable materials, architects introduce natural light into the architecture to the greatest extent, allowing employees to enjoy the lush courtyard while working. The large-area glass curtain wall structure enables the structural layer to be heated in winter and ventilated in summer to minimize energy consumption throughout the year.

Figure 31 : SAIC Volkswagen Integrated Management Building Overview [Drawing]. Retrieved from https://www.archdaily.cn/cn/950606/shang-qi-da-zhong-qi-che-you-xian-gong-si-ji-zhu-guan-li-zhong-xin-er-qi-b-plus-h-architects

Especially for Integrated Management Building II, the glass curtain wall includes a double-layer system, and its supporting structure is inserted inside and fixed by galvanized elements. On the south side of the architecture, they act as ventilation devices for thermal regulation, and on the north side, they serve as heat compensation tools. This environment is created by adopting a wood slat system (standard profiles 40cm x 20cm, which can be optimized into two pieces when cut diagonally), and this system is used as a radiator throughout the project.

Figure 32 : Integrated Management Building II Overview [Photograph]. Retrieved from https://www.archdaily.cn/cn/950606/shang-qi-da-zhong-qi-che-you-xian-gong-si-ji-zhu-guan-li-zhong-xin-er-qi-b-plus-h-architects

Integrated Management Building II is inspired by the concept of "embracing yang while backed by yin" in traditional Chinese philosophy. The two "L"-shaped architectures embrace each other, symbolizing the complementarity of the forces of Yin and Yang in nature. The two architectures are connected by a corridor bridge to facilitate and encourage interaction among employees.

Figure 33 : The pebble-shaped staff restaurant [Photograph]. Retrieved from https://www.archdaily.cn/cn/950606/shang-qi-da-zhong-qi-che-you-xian-gong-si-ji-zhu-guan-li-zhong-xin-er-qi-b-plus-h-architects

The pebble-shaped staff restaurant achieves a natural transition between the interior of the restaurant and the courtyard and outdoor seating area through floor-to-ceiling glass windows. This vibrant social space creates an inclusive community atmosphere, allowing employees to have pleasant conversations and rest with team members in a relaxed atmosphere. The floor-to-ceiling windows create a visual connection between the indoor and outdoor spaces, providing natural lighting and allowing employees to enjoy the pleasant landscape in the courtyard while indoors.

5.1.2.1 Indoor

Figure 34 : First floor of Integrated Management Building [Photograph]. Retrieved from https://www.archdaily.cn/cn/950606/shang-qi-da-zhong-qi-che-you-xian-gong-si-ji-zhu-guan-li-zhong-xin-er-qi-b-plus-h-architects

The first floor of Integrated Management Building contains most of the public facilities and spaces, such as restaurants, convenience stores, retail areas and the atrium. The atrium vertically connects each floor and is also an important manifestation of SAIC Volkswagen's corporate culture: transparency, openness, and connection. The stairs in the atrium encourage employees to have informal meetings, promote collaboration and stimulate inspiration and creativity. At the same time, the atrium also creates a local microclimate by introducing natural lighting and natural ventilation, which helps to improve the physical and mental health of employees. We further demonstrate SAIC Volkswagen's corporate culture through design details. Horizontal lines and lighting fixtures reflect speed, driving force and forward momentum. Blue is widely used in the interior design and decorative walls, echoing the corporate color of Volkswagen.

5.1.2.2 Landscape

Figure 35 : Landscape “SAIC Volkswagen Journey” [Photograph]. Retrieved from https://www.archdaily.cn/cn/950606/shang-qi-da-zhong-qi-che-you-xian-gong-si-ji-zhu-guan-li-zhong-xin-er-qi-b-plus-h-architects

Our landscape design draws on the corporate history and culture of SAIC Volkswagen and is committed to creating a nature-close atmosphere and promoting the physical and mental health of employees. Dense green plants are distributed throughout the park, bringing a unique natural landscape to the park.

A landscape walkway named "SAIC Volkswagen Journey" winds and connects the entrance square of the main architecture and the central courtyard, symbolizing the evolution of SAIC Volkswagen in China since 1984. The planting area at the end of the pedestrian walkway adopts a rain garden design, which is part of the overall rainwater collection and circulation system to reduce surface runoff. The arc of the pedestrian walkway is consistent with the design of the staff restaurant, creating a natural transition between the restaurant terrace and the outdoor landscape design. The courtyard surrounded by two "L"-shaped architectures is located in the center of the park. While encouraging interaction among employees in the park, it also provides employees with many places for viewing and rest, such as floating bridges on the water, stone seats, and lotus ponds.

The landscape design is scattered and distributed to promote seepage and drainage in the park and create a suitable moisture level for the growth of plants. The landscape team of B+H also applies local plants in the park, and this diverse vegetation can grow healthily without too much care. In addition, the green gardens on the architecture roofs also make the project more sustainable. The plantings in the central garden are combined with small trees such as cherry blossoms, osmanthus, gardenias and wintersweet. The stepped flower beds are scattered with 4-5 kinds of evergreen shrubs and herbaceous flowers to create a scene of blooming throughout the four seasons.

5.1.2.3 Summary

Table 5 : Summary of Integrated Management Building

Architectures	Facility	Location	Area mm^2	Opening time			
Integrated Management Building I	Canteen 1	1F	200	7:00 - 9:30	11:00 -13:00	17:00 - 19:00	
	Canteen 2		100	7:00 - 9:30	11:00 -13:00	17:00 - 19:00	
	Lawson		30	7:00 - 20:00			
	Flower shop		10	7:00 - 20:00			
	Starbucks		30	7:00 - 20:00			
	KFC		60	7:00 - 9:30	11:00 -13:00	17:00 - 19:00	
	Pizza Hut		60	7:00 - 9:31	11:00 -13:01	17:00 - 19:00	
	Fitness center		60	7:00 - 20:00			
	Office/Meeting Room	2F - 9F	6000	7:00 - 20:00			
Integrated Management Building II	Canteen 3	1F	400	7:00 - 9:30	11:00 -13:00	17:00 - 19:00	
	IS Coffee		30	7:00 - 20:00			
	Happy Lemon Milktea		10	7:00 - 20:00			
	IT service center		50	7:00 - 20:00			
	Clinic		100	7:00 - 20:00			
	Family Mart		30	7:00 - 20:00			
	Office/Meeting Room	2F - 9F	6000	7:00 - 20:00			
Parking Hall	Parking Hall	1F - 5F	5000	7:00 - 20:00			
	Reception center	2F	100	7:00 - 20:00			
	Lian Hua Supermarket		50	7:00 - 20:00			
	Hair salon		30	7:00 - 20:00			
Outdoor	Rainwater collector	9F	/	/			
	Landscape	1F	/	/			
	Ponds		/	/			

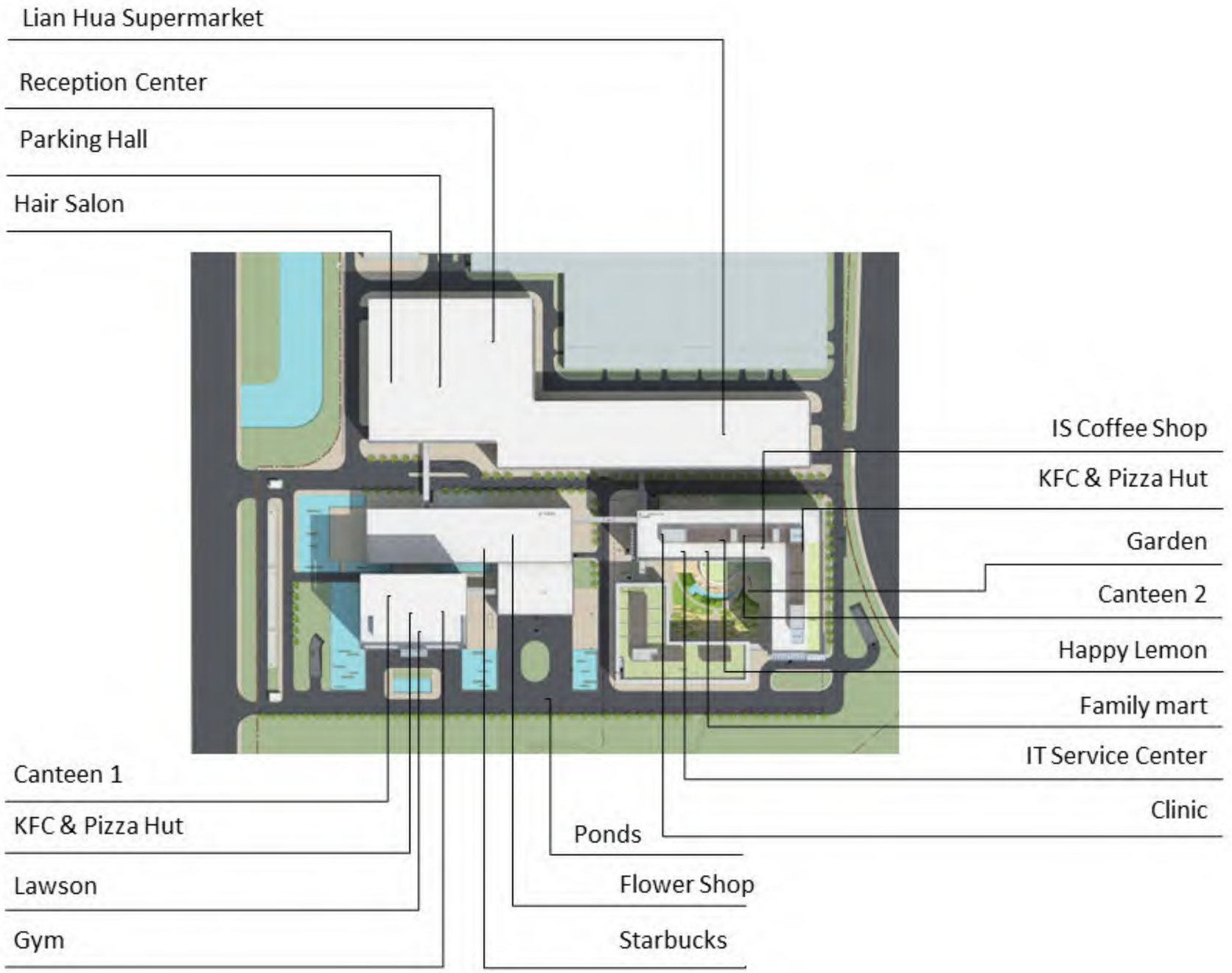


Figure 36 : Plane diagram of Integrated Management Building

The above briefly introduces the general information ofIntegrated Management Building. As an employee working here, for intuitive statistics and understanding, Table 5 summarizes the area division and detailed introduction withinIntegrated Management Building. Regarding place, Table 5 provides detailed descriptions of the characteristics and opening hours of each functional area, thereby better understanding the current situation of integrated management building.

5.1.3 People

There are more than 4,000 employees working permanently in the entire SAIC Volkswagen Integrated Management Building, among whom the main personnel are SAIC Volkswagen 's civilian staff, such as those in marketing, management, personnel, finance, and other positions. Since there are several cafeterias, supermarkets, snack bars and other places in Integrated Management Building, there are more than nearly 100 service staff serving SAIC Volkswagen employees. Similarly, the author himself also works here as an SAIC Volkswagen employee. Since Integrated Management Building is located in an industrial area and there are no residential areas within 1km around, the description of the design object in this article pays more attention to the staff working in the architecture, that is, SAIC Volkswagen employees and service staff serving the employees.

We have designed a set of questionnaires to collect the thoughts and needs of the employees and colleagues who work and live in Integrated Management Building regarding the current architecture. Combined with Integrated Management Building itself, we systemically analyze the targets that can be renovated or optimized in Integrated Management Building.

Table 6 : SAIC Volkswagen employees and Staff in Integrated Management Building

Architectures	Facility	Location	Flowrate per hour	Service Target	Staff	Amount of Staff
Integrated Management Building I	Canteen 1	1F	200	SAIC Volkswagen Employees	Canteen staff	10
	Canteen 2		100			10
	Lawson		60		Store staff	2
	Flower shop		5		Store staff	1
	Starbucks		10		Starbucks staff	3
	KFC		30		KFC staff	5
	Pizza Hut		20		Pizza Hut staff	3
	Fitness center		20		fitness instructor	4
	Office/Meeting Room	2F - 9F	/		/	
Integrated Management Building II	Canteen 3	1F	300		Canteen staff	10
	IS Coffee		10		IS Staff	10
	Happy Lemon Milktea		8		Milk tea staff	2
	IT service center		10		SAIC Volkswagen IT employees	10
	Clinic		10		General practitioner	2
	Family Mart		60		Store staff	3
	Office/Meeting Room	2F - 9F	/		/	
Parking Hall	Parking Hall	1F - 5F	/		/	
	Reception center	2F	20		Security	3
	Lian Hua Supermarket		30		Store staff	3
	Hair salon		3		Hairdresser	1
Outdoor	Rainwater collector	6F	/			
	Landscape	1F	/			
	Pond		/			

5.1.4 Questionnaires

From the above "people" and "place" tables, it is not hard to discover that, apart from the office area, the place with the largest number of people and the most service staff in Integrated Management Building is the one mainly composed of catering and light food. There is a traditional saying in China that food is the first necessity for the people. Therefore, the main objects of our systemic design focus on the office area and the catering area consisting of restaurants, supermarkets, coffee shops, etc. The targeted people are mainly the SAIC Volkswagen employees in Integrated Management Building and the staff in the catering area. Meanwhile, the functionality of other areas and the staff will also be appropriately considered and included proportionally. For the main objects and main people of this design, we have designed the following questionnaire:

Figure 37 : Questionnaire for the employees and staff in Integrated Management Building

SAIC Volkswagen Office Environment Ecological Awareness Questionnaire

Systemic design for regenerative architecture in SAIC Volkswagen Integrated Management Building.

1. Your Gender is _____.

A. Male

B. Female

2. How long have you worked in SAIC Volkswagen Integrated Management Building?

A. 1 - 5 years

B. 5 - 10 years

C. Over 10 years

3. What do you think a regenerative architecture is like?

A. A architecture with high energy efficiency, low pollution, and high environmental protection.

B. An environmentally friendly architecture that improves energy utilization rate during the use process through various means and methods at the beginning of the design.

C. A architecture that organizes various elements by using internal and external spaces to achieve the orderly circulation and transformation of substances and energy.

4. What problems do you think currently exist in our SAIC Volkswagen Integrated Management Building? Especially for the office and catering area (canteen/convenience store/coffee bar)

A. Severe energy waste, such as water, electricity, paper, etc.

B. Garbage classification is not strict.

C. Seriously affecting the surrounding ecological environment.

D. Excessive use of disposable chopsticks and plastic bags.

E. Others _____

5. If garbage classification and recycling are carried out more strictly within Integrated Management Building in order to recycle these garbage resources for reuse, what do you think?

A. OK and willing to do it.

B. OK. It's better to have cleaners do it.

C. Not feasible. It's too troublesome.

D. Not feasible. Other reasons.

6. What resources do you think can be utilized in our Integrated Management Building at present? Especially for the office and catering area (canteen/convenience store/coffee bar)

A. Light resources

B. Water resources

C. Others _____

7. Which of the following types of environmental improvements has the greatest impact on your work?

A. Air quality

B. Water quality

C. Sunlight

D. Noise

8. Under the same conditions, which aspect of the SAIC Volkswagen Integrated Management Building do you think should be improved in 1st priority?

A. Greening of the surrounding environment

B. More facilities or activities for employees within the company

C. Others _____

9. If the company uses recycled resources, for example, using the heat storage system formed by the heat storage tank during the season change to achieve 100% energy self-sufficiency, but at the same time, the comfort level of some body temperature sensation will inevitably be affected. Do you agree or disagree?

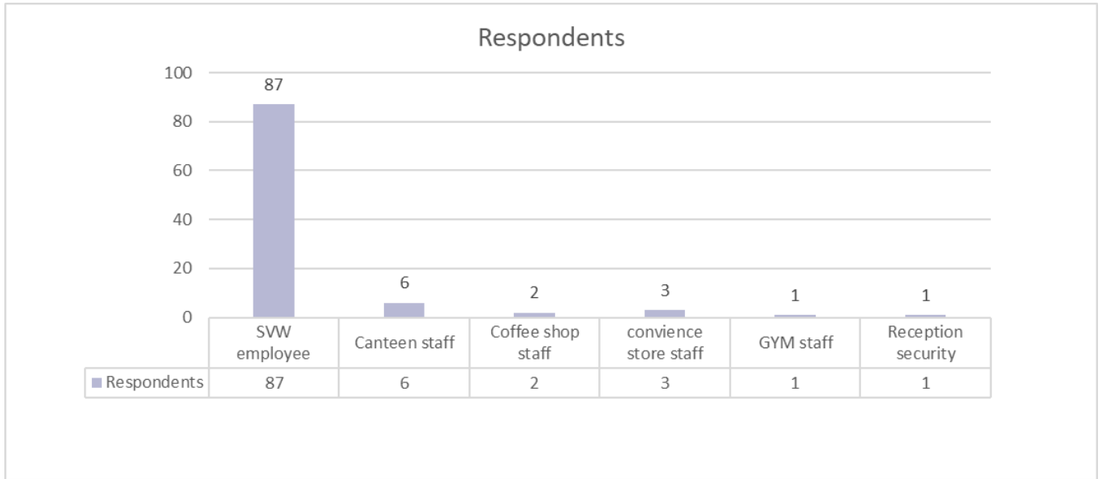
A. Agree

B. Disagree

5.4.1.1 Questionnaire object

We sent the questionnaire to a total of 100 SAIC Volkswagen employees and related service staff working at SAIC Volkswagen, among them, there were 87 SAIC Volkswagen employees, 6 canteen staff, 2 coffee shop staff, 3 supermarket staff, 1 gym staff, and 1 front desk security guard.

Table 7 : Composition of respondents



5.4.1.2 Questionnaire result

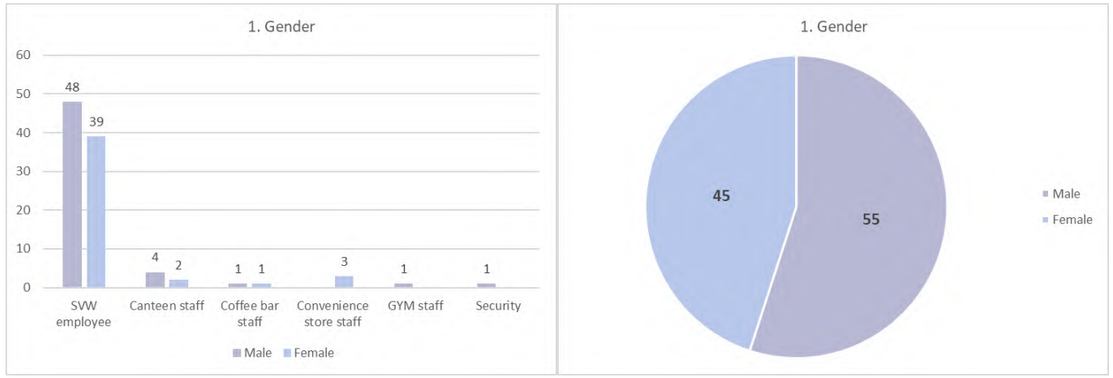


Figure 38 : Questionnaire result 1 - Gender of respondents

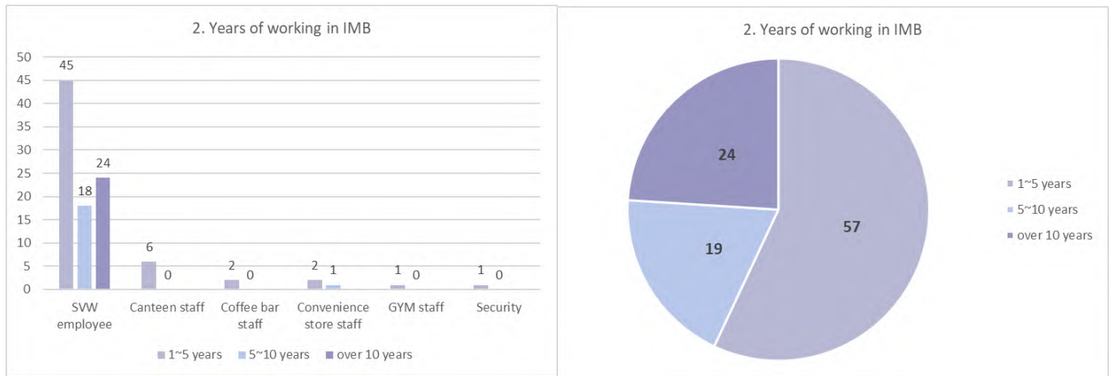


Figure 39 : Questionnaire result 2 - Working years in Integrated Management Building of respondents

The genders and working years in SAIC Volkswagen of the respondents are presented as Figure 38 and Figure 39. As the headquarters architecture of a large manufacturing enterprise, including service staff, the gender ratio is relatively balanced, and the majority are employees who have worked in Integrated Management Building for 1 to 5 years. Due to the current economic situation and the fluctuations in personal career development,

the possibility of working in the same department or location of the same company for a long time is relatively not that high. Meanwhile, for service staff, the personnel mobility within a short period is also very normal.

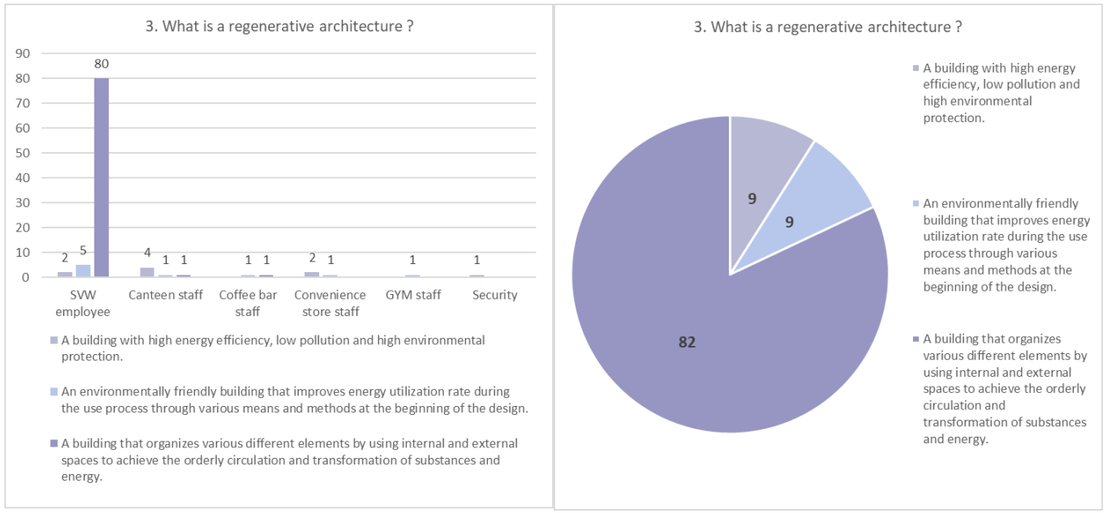


Figure 40 : Questionnaire result 3 - The understanding of the regenerative architecture of the respondents

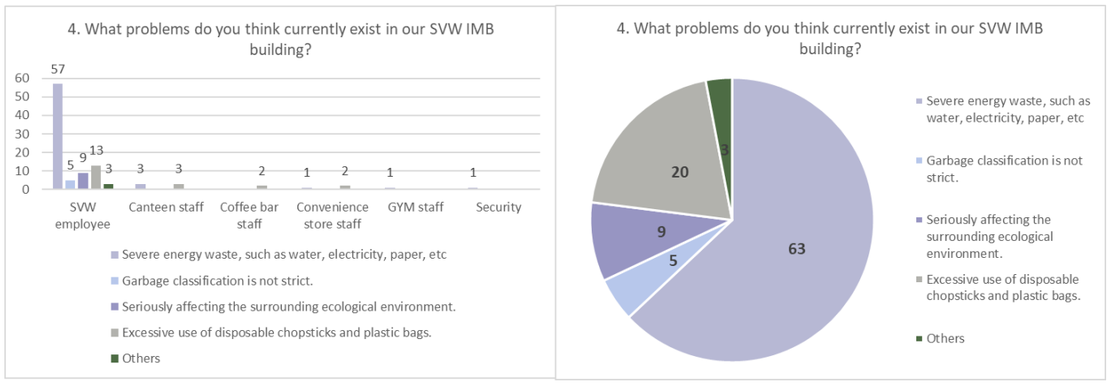


Figure 41 : Questionnaire result 4 - The main problem in Integrated Management Building

From Figure 40 and Figure 41, it can be seen that in fact people have a certain understanding of regenerative architecture. 82% chose the correct answer about the definition of regenerative architecture. More than 63% of the respondents believed that the biggest problem of Integrated Management Building at present is the waste of energy resources, such as water resources and paper resources. At the same time, 20% of the respondents thought that the current garbage classification was not implemented strictly enough. This also reflects from the side that in fact, most of the people currently working in Integrated Management Building are implementing garbage classification relatively strictly, or the garbage classification measures of Integrated Management Building are currently doing not bad.

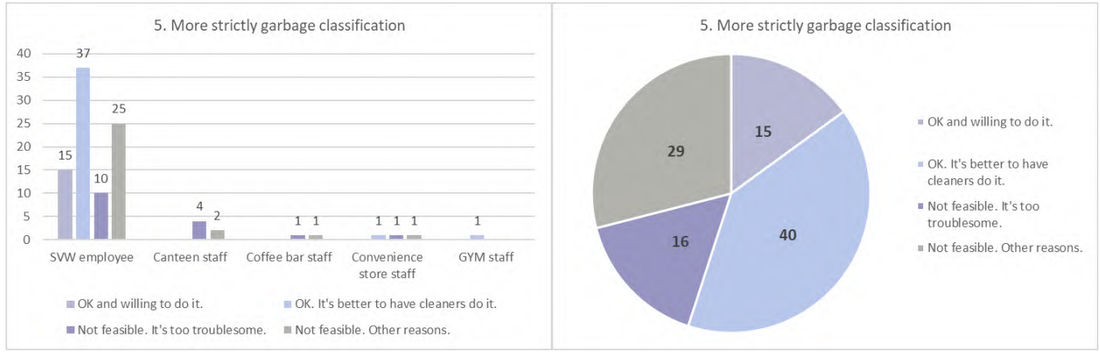


Figure 42 : Questionnaire result 5 - more strictly garbage classification

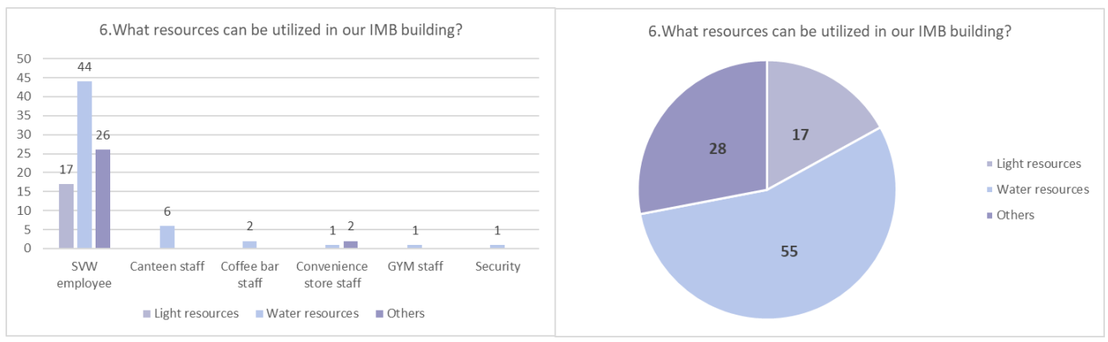


Figure 43 : Questionnaire result 6 - what resources can be utilized?

Figure 42 shows that for garbage classification, more than 50% of people support stricter garbage classification, but the majority of them are unwilling to increase their own workload and instead add this part of the workload to the cleaning staff. At the same time, Figure 43 shows that more than half of the respondents believe that the water resources in Integrated Management Building are currently wasted seriously and can be attempted to be recycled. Additionally, 26% of the respondents think that the light resources of Integrated Management Building can also be attempted to be utilized.

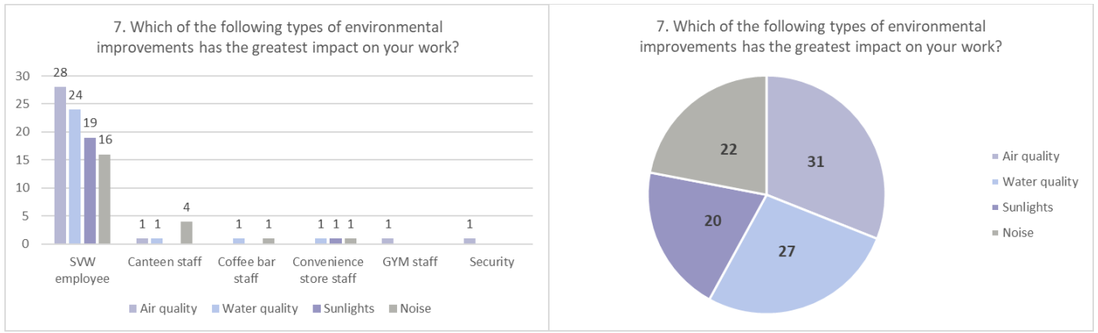


Figure 44 : Questionnaire result 7 - the greatest improvement of environments

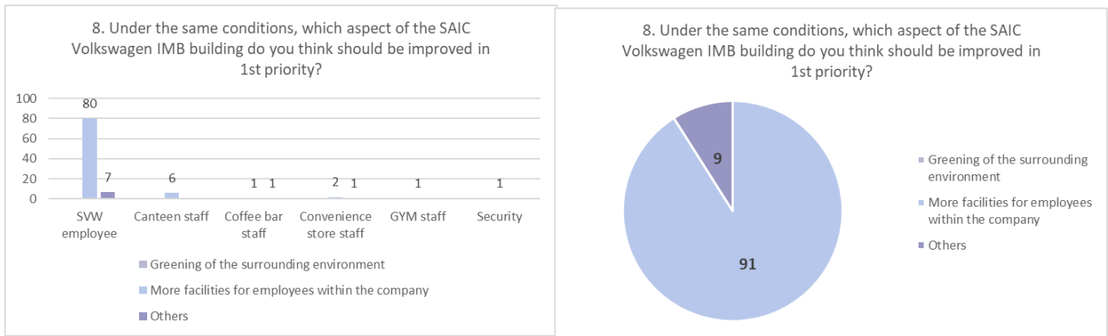


Figure 45 : Questionnaire result 8 - Improvement of 1st priority

Figure 46 : Questionnaire result 9 - The influence for recycling resource

Figure 44 shows that the respondents' assessment of the influence of environmental factors such as water quality, air quality, noise and sunlight on work is relatively average. Each of the four aspects is almost around a quarter, which also means that Integrated Management Building has achieved a relative balance in these four aspects. Regarding the improvement of work by facilities and activities or the green environment, more than 91% chose more facilities and activities, which means that the green garden design introduced at the beginning of the design of Integrated Management Building has satisfied the people working here. But the last survey also indicates that the recycling of energy does not affect people's quality of life. More than 66% of the respondents are unwilling to reduce the comfort of the environment where they are due to the use of renewable energy. In other words, when using regenerative resources, energy users should feel the least difference between regenerative resources and traditional resources.

5.1.5 Purpose and principle

Based on the results of the survey, as a summary, we draw the following conclusions as purpose and principle:

From the perspective of systemic design, the regenerative modification of Integrated Management Building should not affect the life and environmental quality of the people working in Integrated Management Building first. At the same time, it should also minimize the additional workload brought by the regeneration transformation to people. People currently working here are relatively satisfied with the current ecological environment. The core demand is the addition of some functional facilities and activities. More regenerative modification can be considered within the ecological environment / functional facilities / activities.

For energy utilization, the recycling of water resources is the highest demand of people, followed by light energy.

In Integrated Management Building, the awareness and current situation of garbage classification have already had a certain foundation. The regenerative transformation can be combined with garbage classification to achieve the goal of resource recycling.

5.2 Systemic design process for the current design of IMB

Currently, the main area of concern in system design is the localized production-consumption system. It focuses on the participants, assets, and resources of local socio-economic activities, aiming to establish synergistic connections between production processes, natural processes and surrounding areas (Peruccio, P. P., Vrenna, M., Menzardi, P., & Savina, A., 2018). More specifically, this approach prompts us to design/plan a circular system of materials, energy and information, reducing waste streams and creating new opportunities by converting the output (waste) of each system element into the input (raw material) of another element. This kind of positive interaction and cooperation among different stakeholders can lead to new localized value chains (Barbero S, Fassio F., 2011).

Based on the "People" and "Place" in the Systemic Design Practice Wheel, from a systemic analysis perspective, the current energy outputs of each” Sub-system” in Integrated Management Building are clearly depicted as shown in the figure 47. Integrated Management Building can mainly be divided into four parts, also be called four sub-systems: the parking hall, Integrated Management Building I, Integrated Management Building II and ponds.

The parking hall includes the parking area, a reception center, a hair salon and Lian Hua supermarket. The main outputs of the parking hall are harmful gas which affects the environment, expired food, and recyclable packing boxes. Both Integrated Management Building I and Integrated Management Building II have office/meeting rooms, canteens, fast food shops, coffee shops, convenience stores, milk tea shops and bread shops. The

main outputs among them are kitchen waste, expired food, coffee grounds, packing and a large amount of waste office equipment. Additionally, Integrated Management Building I also have a flower shop. The main output is waste wares and plant waste, and the main output of the fitness center is used fitness equipment. While Integrated Management Building II has an outdoor garden alone. Currently, some ornamental plants are mainly grown, allowing employees to relax in the garden during breaks.

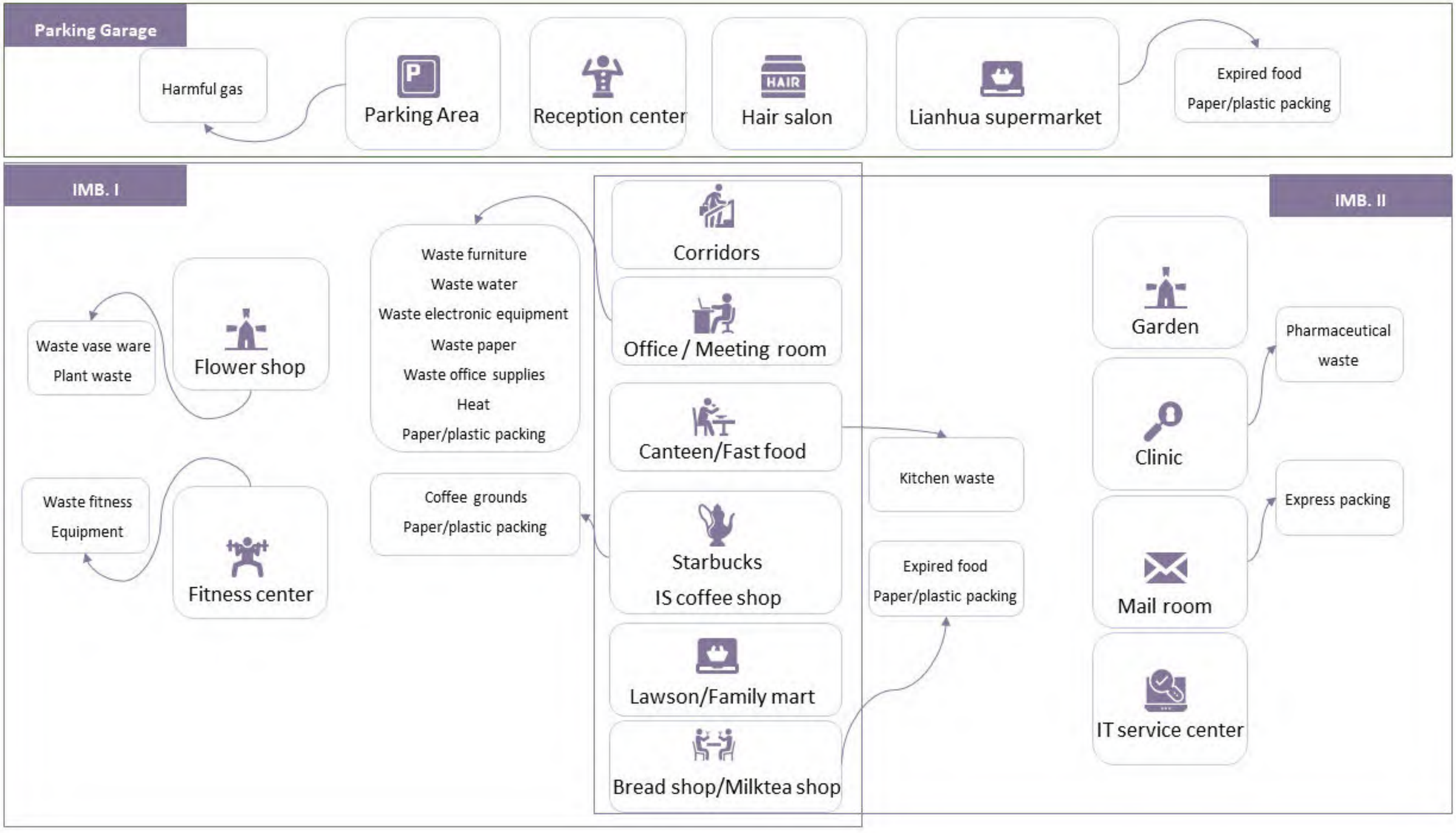


Figure 47 : Energy outputs of each part in Integrated Management Building, drawn by author

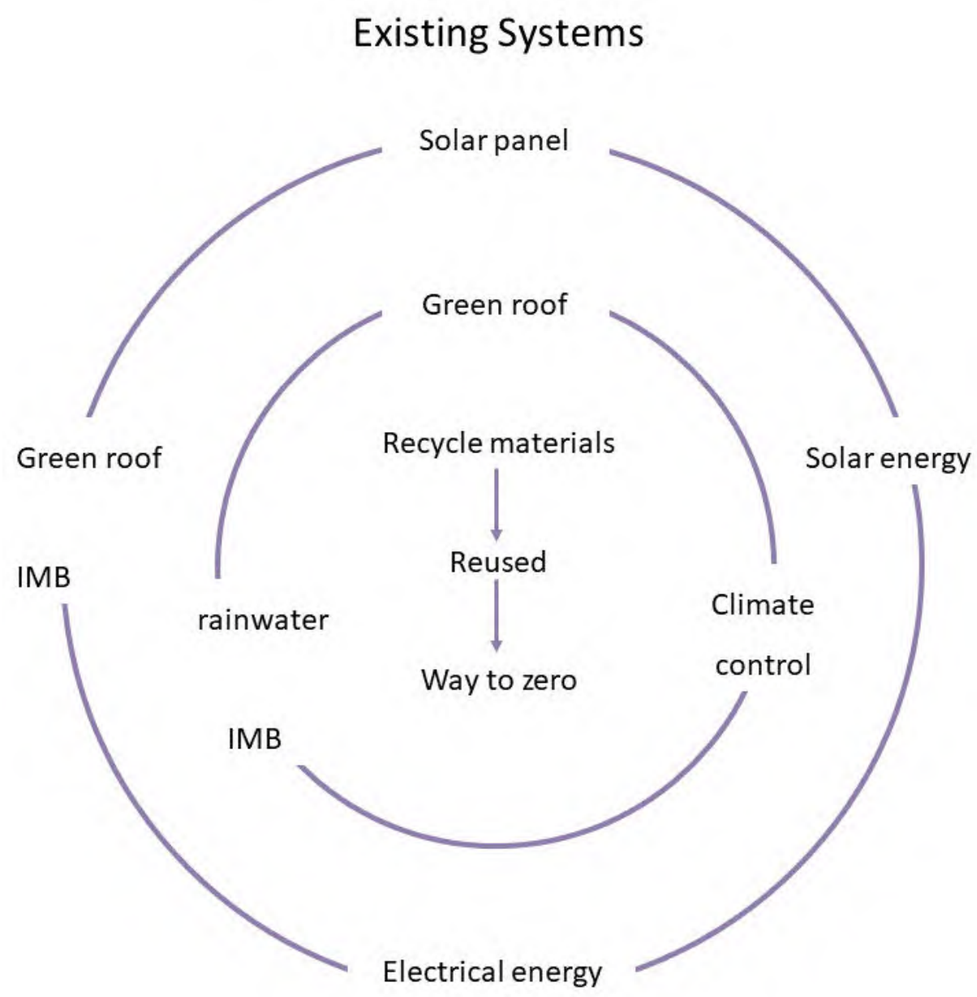


Figure 48 : The regenerative system model of current Integrated Management Building, drawn by author

According to the current regenerative system model of Integrated Management Building, it can be seen that the main system circulation and regeneration are reflected in the utilization of natural resources.

Sunlight is converted into solar energy through solar panels and eventually into part of the electrical energy used by Integrated Management Building. Rainwater is collected through the roof garden of Integrated Management Building. During the evaporation process, the rainwater takes away the temperature at the top of the architecture, enabling Integrated Management Building to maintain a relatively low temperature in summer and thus reducing the use of air conditioners. Finally, Integrated Management Building is also actively conducting garbage classification and garbage recycling and reuse, and through garbage classification, recycling and reuse, the goal of zero-waste is achieved.

5.3 Systemic design practice for regenerative Integrated Management Building

Systemic design practice for regenerative Integrated Management Building

According to the requirements of systemic design, the design object is regarded as a subsystem and placed in the entire objective environment related to it. For regenerative architectural design, the essence of regenerative architectural design is a design method based on systemic thinking. The regenerative architecture itself, as a subsystem, produces resources such as water, energy, and food. The modification of Integrated Management Building mainly connects each space of Integrated Management Building through systemic design means to be as self-sufficient as possible.

Introducing regenerative architecture design into Integrated Management Building has numerous benefits. It helps reduce the environmental impact by minimizing energy consumption and waste generation. It also enhances the resilience of Integrated Management Buildings, making them better adapted to changing climatic conditions. Moreover, it promotes the use of sustainable materials and technologies, contributing to a greener and healthier living environment.

5.3.1 Waste recycling and utilization

Waste refers to the emissions generated during production and construction, daily life and other social activities that have basically or completely lost their use value within a certain time and space range. Garbage is the most common kind of waste.

Based on the investigation of Integrated Management Building, we found that in Integrated Management Building, garbage classification has a relatively good foundation. People have been implementing relatively strict garbage classification and their feedback or impression of it is also relatively positive. Naturally, the recycling and reuse of waste is an unavoidable topic.

For regenerative architecture design, the main wastes of Integrated Management Building at present can be classified into 2 types: organic wastes, and office supplies.

5.3.1.1 Organic wastes

Organic wastes It refers to perishable biomass domestic wastes such as food material waste, leftovers, melon peel and fruit core, and traditional Chinese medicine dregs.

This type of garbage is produced in residents' daily lives and activities such as food processing, catering services, unit meal supply, etc. Its main sources are household kitchens, restaurants, hotels, canteens, markets, and other industries related to food processing.

5.3.1.1.1 Coffee grounds

According to the feedback from the two coffee shops, the two coffee shops in Integrated Management Building produce a total of approximately 15kg of coffee grounds per day (about 10kg from Starbucks and about 5kg from IS Coffee). As a green raw material, coffee

grounds, after fermentation and combination with soil, can fertilize plants that prefer nitrides and most four-season plants. Currently, coffee grounds as plant fertilizer have been widely recognized.

There are two coffee shops in the SVW building. Among them, the coffee grounds of the IS coffee shop can be provided for employees to take home for free.

Figure 49 : The dried coffee grounds can be taken away and reused by the employees for free

Figure 50 : Bring home coffee grounds as fertilizer

Figure 51 : Bring home coffee grounds as an air fresher

Figure 52 : Bring home coffee grounds as scented candle

Employees take the coffee grounds home. The most direct use is to directly fertilize the plants at home as fertilizer. The coffee grounds contain 1.4% - 1.56% of nitride, 2.6% - 3.7% of phosphate, and 0.32% - 0.37% of potassium (accounting for dry matter). They are similar to organic fertilizer in composition and can be used as a safe and pollution-free fertilizer, as shown in Figure 49.

At the same time, coffee grounds also have a porous nanostructure, which means that like activated carbon, it has the functions of adsorbing impurities, deodorizing and antibacterial. Coupled with its natural aroma, it has become the raw material for many products.

Besides, other recycling values of coffee grounds remain to be deeply explored. In the future, the coffee grounds from the two coffee shops in Integrated Management Building can be fully regenerate.

The recycled coffee grounds will be crushed and spread evenly in containers, exposed to the sun or in the oven to ensure they are completely dried. The completely dried coffee grounds can be taken away for free by employees. As shown in Figure 50, employees can take home the dried coffee grounds freely as pollution-free fertilizer.

Meanwhile, according to the previous questionnaire survey, people working in Integrated Management Building most hope to obtain more functional facilities and activities. Coffee grounds can be used as the raw material for the activities organized by the labor union. For example, after work, a handicraft class is organized once a week in the first factory, using coffee grounds to make soap, deodorants, etc. While recycling materials, it also meets the needs of employees. Figure 51 & 52 show the coffee grounds products that can be made through simple handicrafts, such as simple deodorizing bags, handmade scented candles. During the production process, on the one hand, it fulfills the employees' desire to relax after work, and on the other hand, it enables the coffee grounds to be fully recycled.

Figure 53 : IMB.I washroom coffee grounds air freshener

Figure 54 : IMB.I Nursing room coffee grounds deodorizing packet

Since May 2024, coffee grounds provided by IS coffee have been packed by IMB cleaning staff in non-woven bags to make deodorizing packets, which have been gradually placed in the restrooms of IMB employees. Half a year has passed, and during this period, this initiative has received unanimous praise from IMB employees. Below is an employee interview conducted on the coffee grounds deodorizing packets:

Interview Date: Thursday, September 12, 2024

Interview Method: Face-to-face

Interviewer: Zhang Yumeng from VE

Interviewee: Zhou Hongyi from PVO

Brief Introduction of Interviewee: Zhou Hongyi, Product Line Management Manager. 30 years old, from Shanghai, joined SAIC Volkswagen in 2019.

Purpose of the Interview: To further understand the effect of recycled coffee grounds on purifying the IMB restrooms and the significance and impact of the act of recycling and reusing coffee grounds and other waste on IMB employees.

Interview Content:

1. What is your opinion on the company's initiative to recycle and reuse coffee grounds?

The act of recycling and reusing is inherently very meaningful. By repurposing the coffee grounds that coffee shops don't want, we can take them home for free and use them in various ways, which not only protects the ecological environment of IMB but also benefits every employee.

2. What is your opinion on making coffee grounds into deodorizing packets and placing them in the restrooms?

It's a fantastic idea. It can reduce the purchase of purifying green plants for IMB, saving the company some expenses.

3. Over the past six months, has the coffee grounds deodorizing packet had any practical effect?

Like other air purification products, the purification of the air is invisible, but it definitely has a practical effect. Every time I enter the restroom, I first smell the scent of coffee.

4. Do you have any other good suggestions for the use of coffee grounds?

I am not particularly knowledgeable about the recycling and reuse of coffee grounds, but I heard that the union is about to launch a related handicraft activity, turning coffee grounds into treasure by making coffee-scented soap, which I think is a particularly cool thing.

Additionally, there are many other ways to reuse and repurpose coffee grounds.

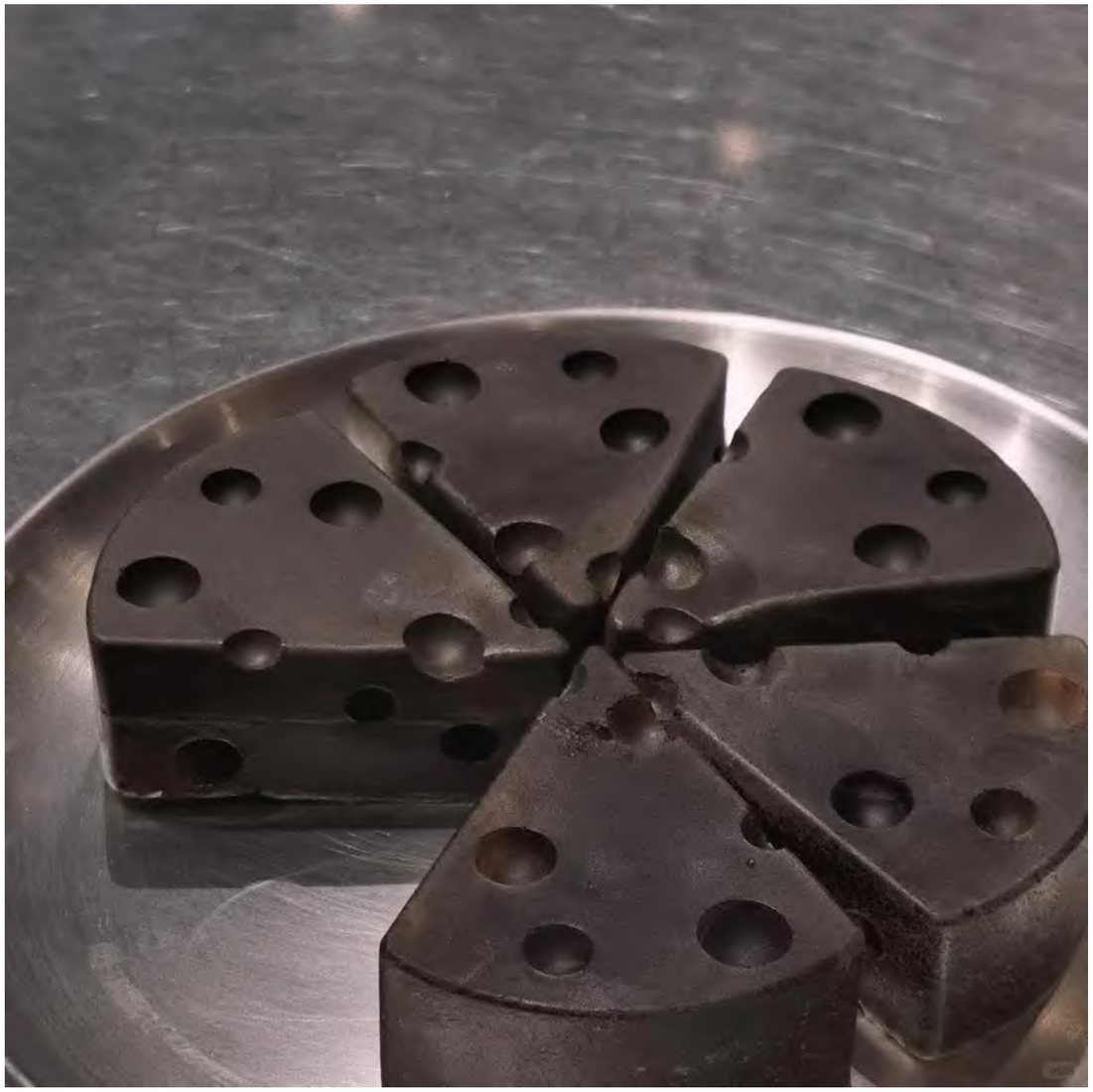


Figure 55 : Coffee grounds soap

Figure 56 : Coffee grounds travel cup and coffee grounds notebook. Retrieved from https://coffeebased.nl/en/product

The studio of designer Paola Sakr has crafted a series of practical tools fashioned from diverse organic waste materials such as coffee grounds and discarded newspapers. These wastes are exquisitely combined with natural adhesives, giving rise to an array of biodegradable and practical containers. She gathers coffee grounds from local coffee shops and then blends them with natural adhesives like newspapers and paper pulp. Through meticulous hand-shaping, containers of various sizes are created. They are not only dainty in appearance but also exude the lingering fragrance of coffee.

Figure 57 : Tableware made of coffee grounds. Retrieved from https://www.paolasakr.design/morning-ritual

Figure 58 : Boomerangs, ping-pong paddles and mobile tables and chairs made of coffee grounds. Retrieved from https://www.brandstar.com.cn/news/6445

As show in Figure 57 & Figure 58, after processing and mixing with other waste organic materials such as wastepaper, coffee grounds can be processed into office furniture and office supplies, such as desks, notebooks, etc. In the future, Integrated Management Building will uniformly collect coffee grounds from coffee shops, entrust external

processors for treatment, and then return to the company in the form of office supplies or souvenirs.

Table 8 : Recycling of the coffee grounds used in SAIC Volkswagen

	Realized	Suggested	Idealization
Fertilizer	√		
Air Purification	√		
Deodorizing Packet	√		
Soap		√	
Coffee Cup		√	
Tray		√	
Storage Box	√		
Bookmark	√		
Simple Desk			√
Rest Pavilion			√

- Realized：already implemented through union activity days or other means
- Suggested：suggestions have been submitted to the union for organization and conduct of related activities at the next labor union activity day
- Idealization：due to excessive financial, human, and material resources required, it is temporarily not feasible to implement

5.3.1.1.2 Other organic wastes

There are nearly 6,000 employees in Integrated Management Building. Besides the two staff canteens on the first floor, there are also fast-food restaurants like KFC and Pizza Hut, as well as light food stores such as milk tea shops, juice stores and bakeries providing daily dietary needs for the employees. The kitchen waste generated from daily catering is mainly treated by landfill and incineration. However, both methods have various environmental and health risks. The most significant problem with landfill treatment is the generation of foul odors, which affects the lives of nearby residents. The landfill waste, under the dual action of microorganisms and high pressure, will also produce landfill leachate containing carcinogens. If this leachate flows into farmland, rivers, or groundwater, it will cause secondary pollution. Moreover, if kitchen waste cannot be properly classified and treated, it is prone to enter mixed waste for incineration, generating toxic and harmful substances such as dioxins.

In addition, both waste treatment methods emit a large amount of greenhouse gases, exacerbating climate change. Similarly, the fiber waste generated by the textile industry can pollute water bodies, enter our food chain, and largely harm terrestrial and underwater organisms.

In recent years, more low-carbon and environmentally friendly kitchen waste treatment processes such as aerobic composting, anaerobic fermentation and insect conversion have gradually become popular. Compared with traditional landfill and incineration, these processes achieve better resource utilization. The treatment mode of the newly built kitchen waste treatment plants is also shifting from a single mode to a comprehensive treatment mode.

So far, in the kitchen waste treatment stage of Integrated Management Building, the resources in the kitchen waste are fully utilized through methods such as aerobic composting, anaerobic fermentation and insect breeding. The kitchen waste is degraded into green waste and finally into organic fertilizers, which are directly used for the planting of flowers and plants in the garden of Integrated Management Building.2, realizing the reuse of kitchen waste.

Figure 59 : The leather substitute Kudarat leather synthesized from algae, food and fiber waste

Furthermore, looking at kitchen waste from the perspective of the regenerative cycle design concept, kitchen waste can also be a "golden resource". Designer Divya Verma from the Indian Design Institute Kudarat synthesized a leather substitute using algae, food, and fiber waste from kitchen waste.

Kudarat leather (as shown in Figure 59) is similar to animal leather, but without actually slaughtering animals. It has the advantages of being waterproof, compostable, and antibacterial. Besides, this kind of leather has good tensile strength and is very suitable for practical applications.

Kudarat uses natural fiber waste and bonds it together using natural adhesives, algal biopolymers, and natural waterproofing agents. After the bio-leather sheets are made, they are dyed using natural colors from food and flower waste, such as vegetable peels, walnut shells, wood chips, roses, and marigolds.

The development of the material does not require a large amount of land or water resources, nor does it lead to carbon emissions. It contains no chemicals. The production requires a temperature below 100 degrees Celsius and is energy-saving. The appearance, touch and durability of this leather are as long as those of traditional animal leather. It is even suitable for decoration and embroidery... But if discarded, it will naturally biodegrade within 8-12 weeks without leaving harmful chemicals.

Figure 60 : A flower pot made of agar, glycerin, water and any dried and crushed food waste, designed by Hutsama

Figure 61 : Kitchen waste pigments made from food residues avocado seeds, red cabbage and orange peels

Kitchen waste pigments made from food residues such as coffee grounds, avocado seeds, red cabbage, and orange peels represent another new trend in the recycling and reuse of kitchen waste. Natural pigments are achieved by combining dyes with inert binders (metal salts) to convert soluble dyes into insoluble pigments. First, immerse the food residues in liquid to extract the dye. Mix the dye with metal salts and use alum and washing soda (as alkali). Once the alkali is added, the alum becomes solid again. The color will adsorb and stick to the alum. When it is filtered out from the remaining dye solution, it is dried and ground to make the pigment.

This kind of kitchen waste pigment is not only environmentally friendly but also sustainable. Its production utilizes kitchen waste that would otherwise be discarded, which is an embodiment of the circular economy and in line with the goal of sustainable development. Secondly, kitchen waste pigments are natural and harmless. Since they are derived from natural ingredients, kitchen waste pigments usually contain no or very few chemical additives, which are more friendly to users and the environment, reducing potential risks to human health and the ecosystem. Thirdly, using natural materials for dyeing and painting is a traditional skill in many ancient cultures. The revival of kitchen waste pigments is not only the inheritance of traditional culture but also a modern innovation that can inspire new artistic creation inspirations.

Finally, converting kitchen waste into valuable pigment products can create new business opportunities and jobs, injecting green impetus into the economy.

Kitchen waste pigments can not only be used in the field of artistic creation. Painters and handicraftsmen can use them for painting, tie-dyeing, fabric dyeing, etc. to create artworks. This kind of pigment can add natural colors and textures to the works and is suitable for making handicrafts with environmental protection concepts. It is also used as teaching materials in schools and educational institutions for conducting environmental protection education courses, allowing children to practice with their own hands and understand the importance of kitchen waste recycling. Family members can also use kitchen waste pigments together for various DIY projects, such as making holiday decorations, personalized items, home decorations, etc., to increase the fun of parent-child interaction. Even better, some kitchen waste raw materials can be refined into natural pigments and used to manufacture cosmetics such as lipstick and blush to meet the demand for chemical-free products.

To sum up, the waste of Integrated Management Building is initially recycled and transported to the local waste treatment plant, and after further processing, it is turned into biomaterial and finally transported back to Integrated Management Building. Through the handicrafts made by employees, it becomes reusable resources. So far, the waste of Integrated Management Building has completed the closed loop of internal self-absorption and digestion.

Table 9 : Summary of application methods for kitchen waste recycling

	Realized	Suggested	Idealization
Leather		√	
Flowerpot		√	
Pigments		√	

- Realized： already implemented through union activity days or other means
- Suggested： suggestions have been submitted to the union for organization and conduct of related activities at the next labor union activity day
- Idealization： due to excessive financial, human, and material resources required, it is temporarily not feasible to implement

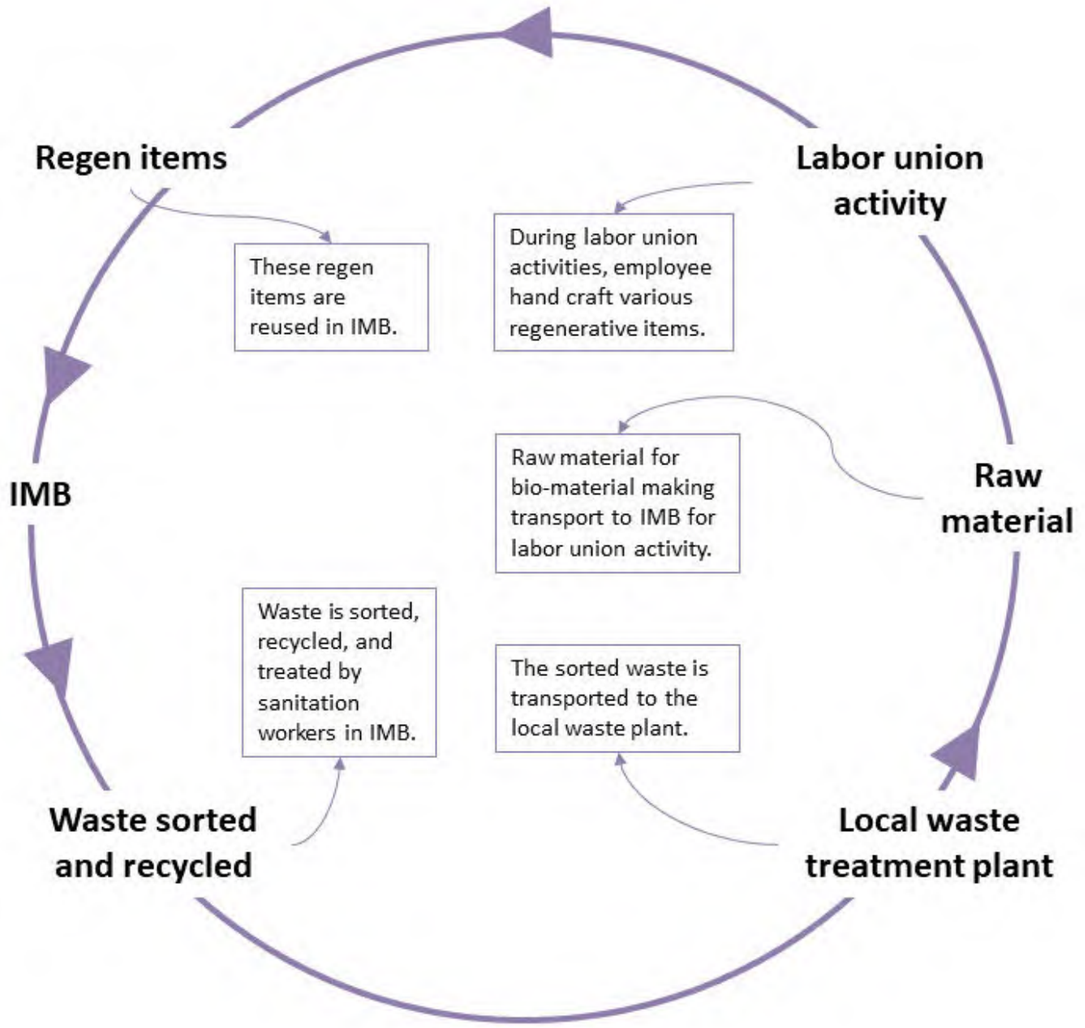


Figure 62 : The waste regeneration path of Integrated Management Building, drawn by author

5.3.1.2 Office supplies

Common consumables in the office space such as printing paper, toner, pens, folders, and other questionnaires, as well as equipment such as computers, printers, keyboards and mice. After being used for a period, they will be exhausted or reach the end of their service life. Effectively disposing of these consumables is not only a matter of environmental awareness, but also involves the company's economic costs and resource utilization.

For various consumables, classification management is required based on types, uses and special attributes. For example, office paper should be classified into different types such as ordinary paper, high-grade paper, and cover paper to facilitate the use of different recycling methods. While discarded equipment such as computers, keyboards, mice, and printers should be evaluated to see if they can be repaired or if there are parts that can be recycled and reused. For consumables that can be recycled and reused, a clear recycling mechanism needs to be specified. For example, recycled paper or stationery needs to be placed in specific recycling bins and kept dry and clean for reuse. At the same time, it is also necessary to negotiate with the recycling processor to deliver the recycled items to the processor on a regular basis.

Some consumables that can no longer be recycled can be processed in various ways to achieve recycling to a certain extent. For example, it can be realized through the "Star Project" launched by SAIC Volkswagen since 2015. The "Star Project" was jointly initiated by SAIC Volkswagen and the China Youth Development Foundation. Up to now, the project has donated more than 16 million yuan in total and has aided in the construction of 11 hope schools to help schools improve infrastructure. Donating these consumables to hope primary schools realizes the reallocation and reuse of resources.

Figure 63: Common office supplies

Figure 64 : Office furniture eligible for recycling in SAIC Volkswagen
Integrated Management Building

First and foremost, the selection of Integrated Management Building office furniture needs to place greater emphasis on the choice and use of environmentally friendly materials. By adopting green and eco-friendly office furniture, not only can we reduce resource waste and environmental pollution, but also pay attention to the post-use phase. That is, Integrated Management Building office furniture has a positive impact on employee health and environmental health throughout its entire lifecycle. In addition, regularly checking the service life and inventory of office furniture, promptly disposing of furniture without repair value, and timely repairing furniture with repair value to extend its service life are also important. Donating excess office furniture can also add more value to it.

Overall, the principal waste produced by Integrated Management Building can be classified into two major categories: organic waste and consumables generated in the office. Kitchen waste and coffee grounds can be transformed into fertilizers through simple means and directly applied to rainwater gardens and ecological ponds. Herein, coffee grounds, as outstanding regen-kitchen waste, assume a significant role in the regeneration system of Integrated Management Building. The treatment approaches for the consumables generated in the office are more diversified, but ultimately, a closed loop of resource regeneration and recycling is established.

5.3.2 Natural resource recycling and reuse – Rainwater

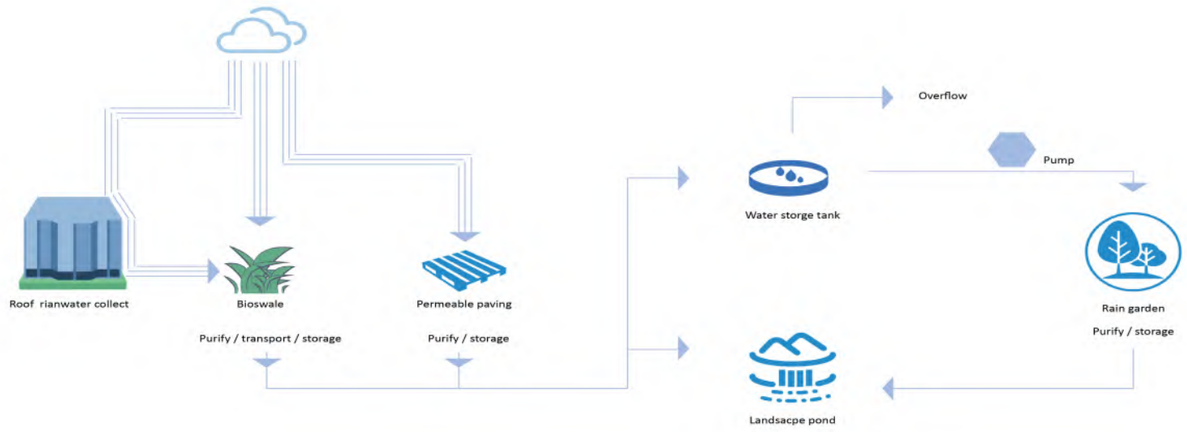


Figure 65 : Rainwater recycling system, drawn by author

For energy utilization, the recycling of water resources is the highest demand of people who work in the SAIC Volkswagen Integrated Management Building. The hard pavement on the roofs of modern architectures generates a large amount of rainwater runoff, and most architectures lack corresponding coastal facilities around them to absorb the rainwater. Then most of the rainwater is discharged to the rainwater pipes, which to some extent will increase the flood discharge pressure of the rainwater pipes. For Integrated Management Building, the roof garden solution is a very suitable means of addressing the issue to make full use of rainwater resources.

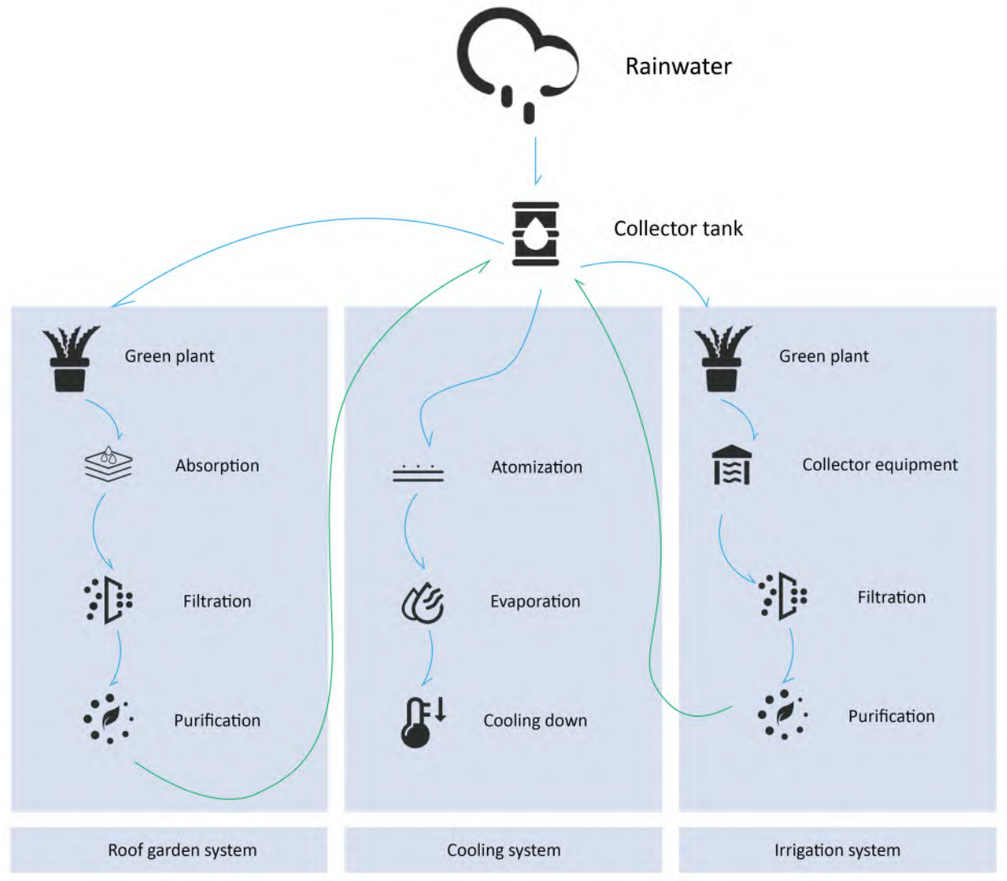


Figure 66 : Roof garden system, cooling system and irrigation system, drawn by author

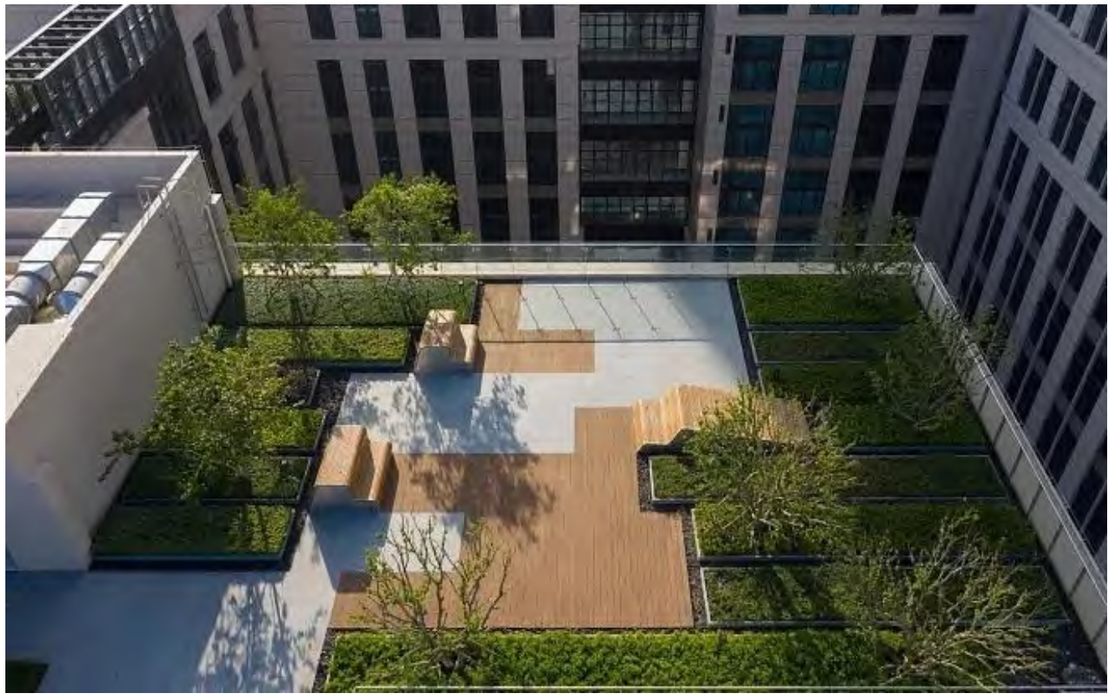


Figure 67 : Schema of the roof garden

5.3.2.1 The roof garden system

The roof garden integrates landscape and architecture. It can not only alleviate the pressure of urban rainwater runoff, but also save various energy consumptions by collecting, storing, and using rainwater for irrigation.

In the roof garden strategy, green vegetation is planted on the surface to absorb excess rainwater runoff. The rainwater is collected into the reservoir for recycling through purification and filtration by plant roots.

The bottom layer of the roof garden has multiple structures such as lightweight soil layer, root penetration prevention layer, drainage layer and waterproof layer for protection, and it can also protect the surface layer of the architecture at the same time (as shown in Figure 68). The green vegetation with diverse plants can absorb the heat of the architecture and reduce the indoor temperature.

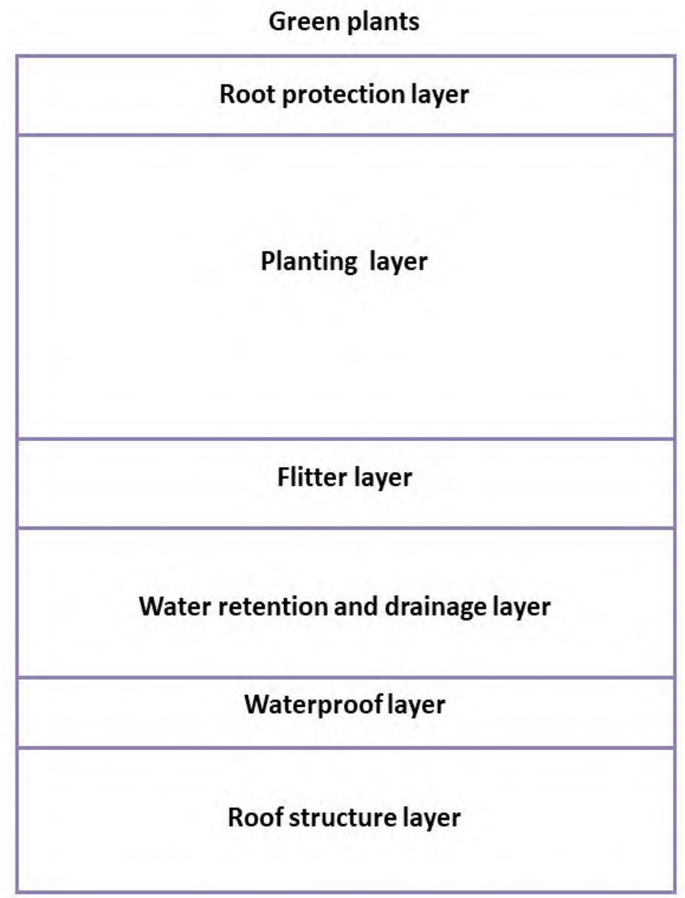


Figure 68 : Schema of the roof rainwater garden, drawn by the author

Figure 69 : Schema of the roof garden of Integrated Management Building Kampung Admiralty / Ramboll Studio Draisaitl and WOHA. Image Courtesy of WOHA

5.3.2.2 Cooling system

In summer, the recycled rainwater can be used for spraying and cooling the roof of the architecture to improve the comfort of the living or working environment, while reducing the use of air conditioners and saving energy. The rainwater recycling and cooling system is mainly completed through the steps of rainwater recycling, rainwater filtration, rainwater atomization, and rainwater evaporation, thereby achieving the cooling effect.

5.3.2.3 Irrigation system

Integrated Management Building II has an atrium garden for employees to relax during breaks; however, currently, the garden only has an ornamental effect. To a large extent, it is a waste of resources, and the function of the atrium garden has not been fully exerted. The WaterAid Garden in Southwest England is a Water Aid garden that takes full account of the recycling and reuse of rainwater for irrigation. The WaterAid garden uses recycled and reused materials to build a rainwater collection pavilion. This rainwater collection pavilion collects every drop of rainwater, filters it, stores it, and finally uses it to irrigate the flowers and plants in the garden. At the same time, it slows down the water flow and provides shade, functioning as a natural "Air-Conditioned Room".

Figure 70 : Water Aid Garden Source

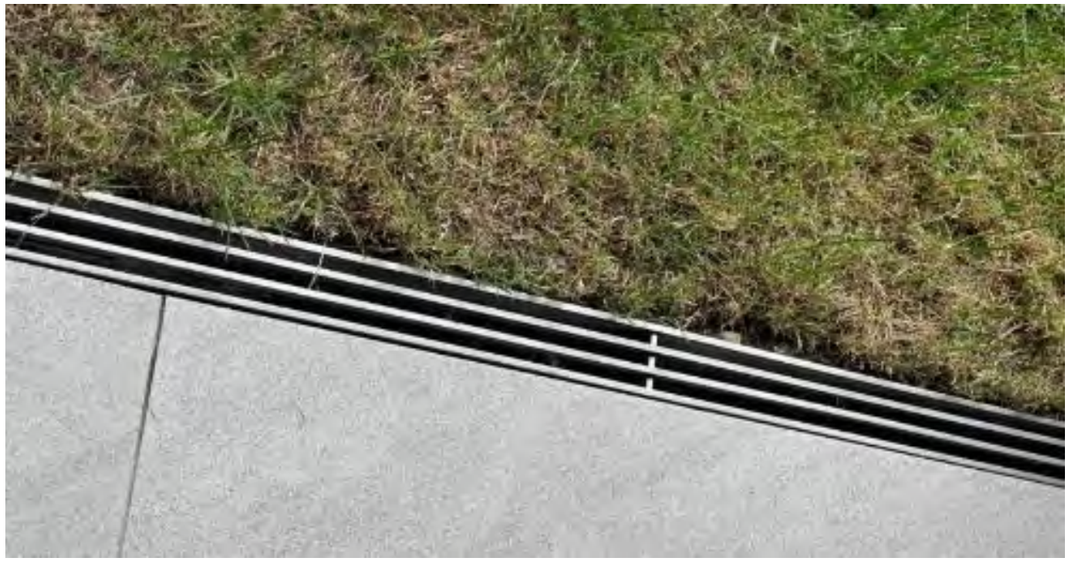


Figure 71 : Integrated Management Building ground water return system

The rainwater collection and regeneration system in greening should also consider the natural infiltration situation and discharge the rainwater that does not meet the storage and infiltration capacity of the green space to the appropriate place.

Table 10 : Summary application of rainwater recycling

	Realized	Suggested	Idealization
Roof garden system	√		
Cooling system		√	
Irrigation system			√

- Roof garden system： At present, the 9th floor of IMB.I has realized the design of a roof garden.
- Cooling system： Based on the roof garden, by using the current equipment and making certain hardware modifications, introducing the collected rainwater into the building's heat exchanger can realize the cooling system.
- Irrigation system： Since the IMB building serves as the company's headquarters, this concept needs the addition of new equipment and changes in waterway management, it can only be regarded as a relatively idealized plan.

- Realized： already implemented through union activity days or other means
- Suggested： suggestions have been submitted to the union for organization and conduct of related activities at the next labor union activity day
- Idealization： due to excessive financial, human, and material resources required, it is temporarily not feasible to implement

5.4 Regenerative module for Integrated Management Building

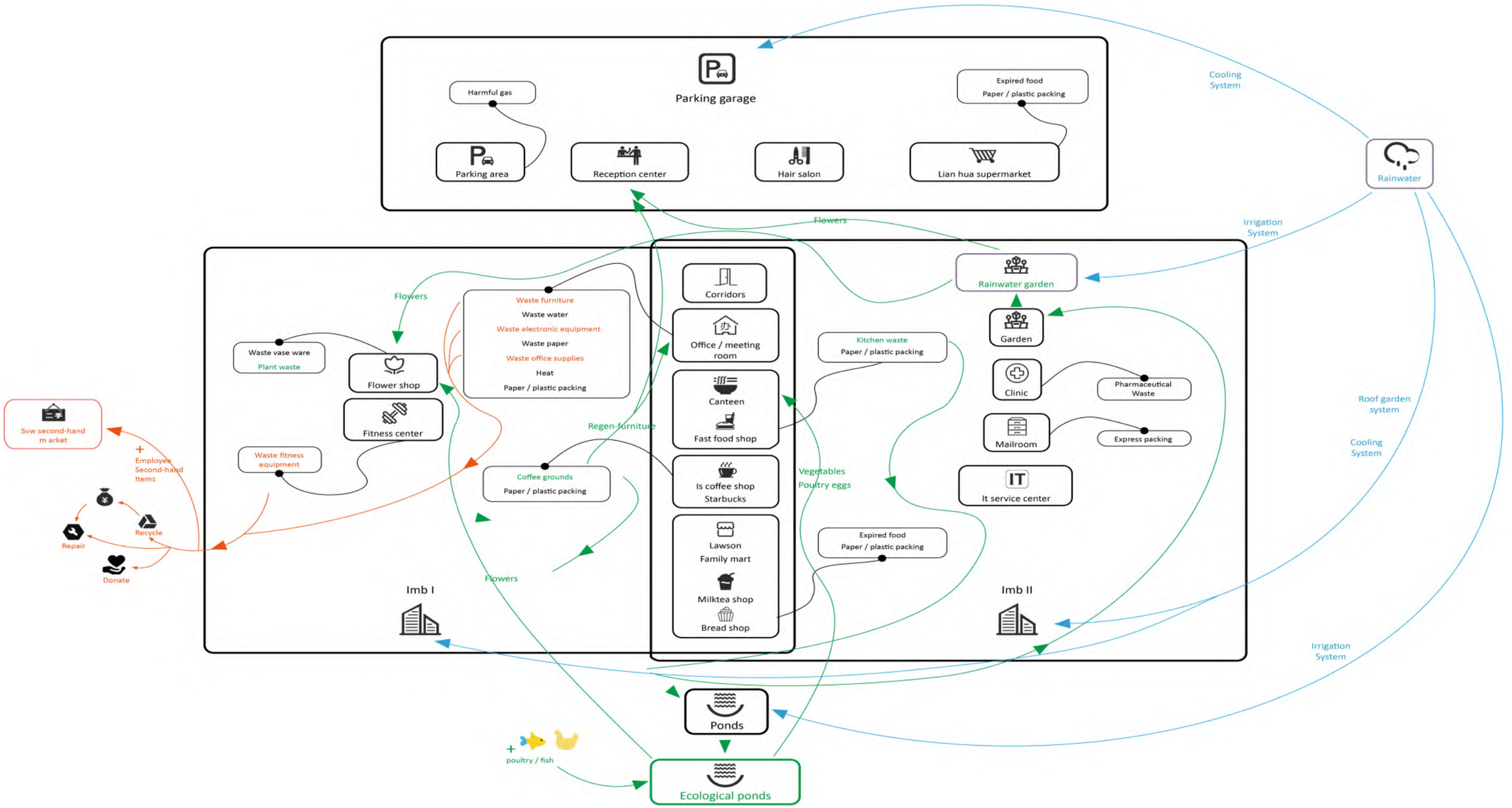


Figure 72 : Regenerative module for Integrated Management Building, drawn by author

5.4.1 Regenerative method for Integrated Management Building - systemic design

By re-integrating various resources of Integrated Management Building, re-arranging and reconfiguring them, it not only helps reduce the waste of Integrated Management Building's resources but also creates economic value and finds a balanced path for Integrated Management Building's ecological protection and humanistic office environment. So far, Integrated Management Building has gradually transformed into a regenerative architecture through systemic design methods, featuring internal resource recycling and reuse, turning waste into valuable resources again, and achieving the systemic circulation process "From Generation to Regeneration".

The systemic design intervention of Integrated Management Building mainly consists of 1. Reducing waste and maximizing the life cycle of products and materials; 2. Recycling, where waste is reprocessed and reused to become new products or raw materials, reducing reliance on natural resources; 3. Energy efficiency, using the least energy in the process of waste conversion to reduce the burden on the environment; 4. Ecological friendliness, ensuring that the entire system cycle has no negative impact on the environment and protecting the ecological balance of Integrated Management Building regenerative architecture and its surrounding environment.

Through waste management, recycling and reusing waste, waste is regenerated and transformed into useful resources, reducing the pressure on natural resources. In addition, the method of transforming Integrated Management Building waste into renewable resources adopts the concept of product design. The original intention of the design is to create regenerative and recyclable products and extend their service life. Sharing is a very important link in Integrated Management Building's systemic design. Through resource sharing, the problem of uneven resource distribution is alleviated, a circular supply chain is established, and waste is incorporated into the production process to achieve a resource closed loop.

5.4.1.1 Rainwater collector - circulating water

By adding new rainwater collection equipment in the garden, the natural resource - rainwater can be saved from being wasted and play a greater role. Through the roof garden system, cooling system and irrigation system, Integrated Management Building, whether it is the office architecture, parking architecture, or the pond and garden, has all become the beneficiary of rainwater.

5.4.1.2 Parking lot - Green plants

Figure 73 : Green plants planted in the parking hall

Green plants from the garden can be partially transplanted to the parking lot space. This can not only alleviate the heat energy emission of the parking lot but also effectively reduce the impact of vehicle exhaust emissions on the surrounding environment.

Coffee grounds – souvenirs/facilities

Such excellent recyclable organic waste as coffee grounds can be processed into recyclable raw materials to make various items needed in the office environment. Through labor union activities, employees can participate in making these items by hand. The final products, such as coffee cups, can also be placed in the visitor center for guests visiting SAIC Volkswagen to take away as souvenirs.

5.4.1.3 Regen materials-rainwater garden/ecological ponds

Some recyclable materials, such as used office chairs and used fitness equipment in the gym, can first be sold through recycling. The money from recycling can be used to repair equipment or devices with repair value. They can also be donated so that such waste can continue to be of useful value.

5.4.1.4 Organic waste- rainwater garden/ecological ponds fertilizers

Integrated Management Building originally had two places for employees to visit and unwind: the garden and the pond. Under the intervention of systemic design approaches, both have undergone their respective upgrades. The pond gradually transformed into an ecological one by adding poultry and fish. The garden became a from the cafeteria and fast-food restaurants is used as fertilizer for the ecological pond and the rainwater garden, while the products of the ecological pond and the rainwater garden, such as local green plants, flowers, poultry eggs, etc., are transported to the cafeteria and flower shops as

perfect raw materials. Everyone becomes a part of the system through this connection, and from then on, the individual is no longer isolated.

Table 11 : Conclusion of regenerative module for IMB

	Realized	Suggested	Idealization
Coffee grounds	√	√	√
Food waste		√	
Office supplies	√	√	
Rainwater	√		√

- Coffee grounds : For detailed information, please refer to Table 8.
- Food waste : For detailed information, please refer to Table 9.
- Office supplies : SVW has now established a warehouse for second-hand office supplies and has achieved the goal of donating second-hand office stationery to Hope Primary Schools and reusing lightly damaged office furniture through basic maintenance.
- Rain water : The rainwater garden has been implemented, but the cooling system and irrigation system require more manpower, material resources, and even financial resources to be realized.

- Realized：already implemented through union activity days or other means
- Suggested：suggestions have been submitted to the union for organization and conduct of related activities at the next labor union activity day
- Idealization：due to excessive financial, human, and material resources required, it is temporarily not feasible to implement

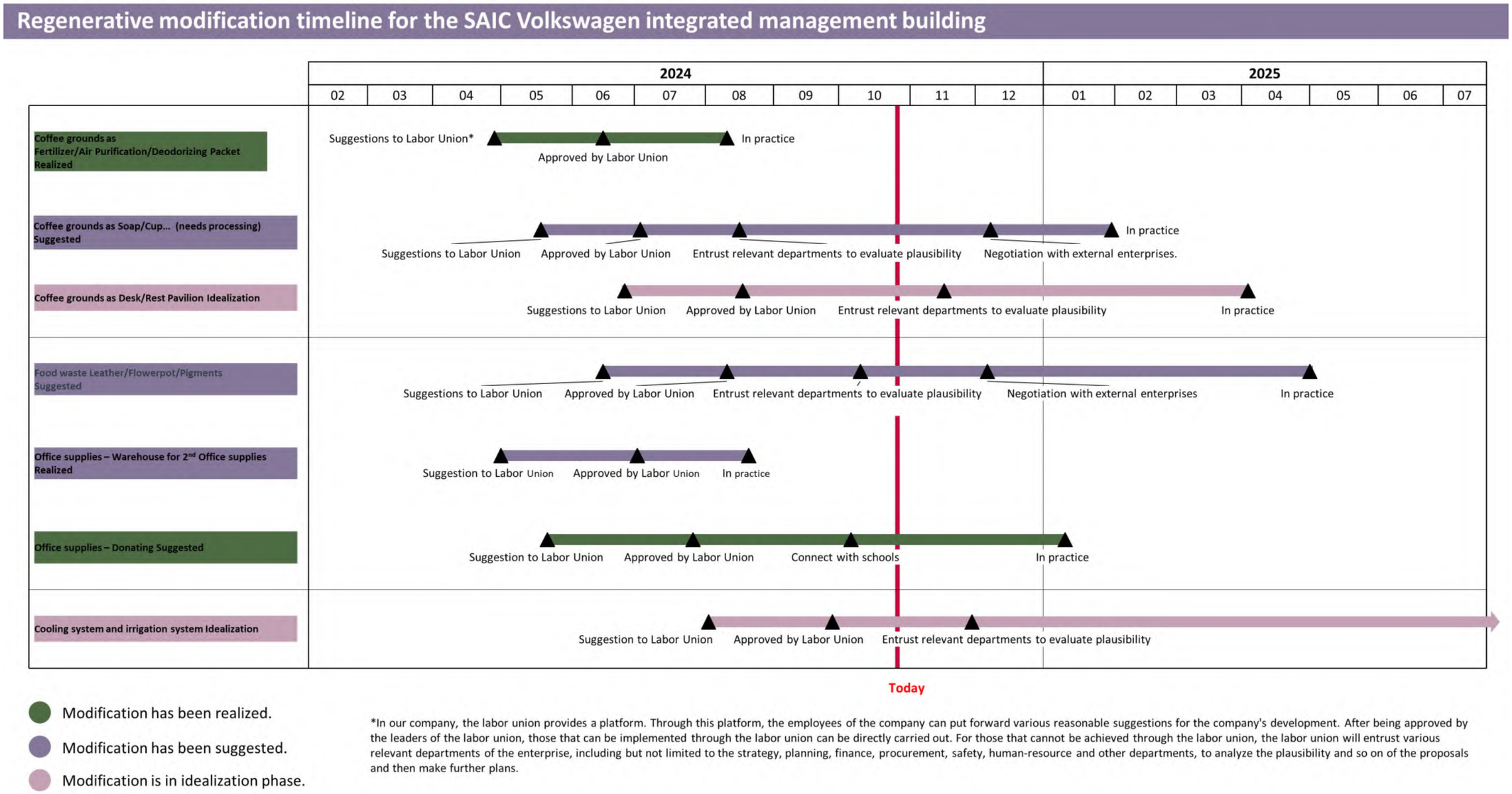


Figure 74 : IMB regenerative modification timeline

5.5 Validation and verification

5.5.1 Validation

Based on the results of the survey, as a summary, we draw the following conclusions as purpose and principle:

1. From the perspective of systemic design, the regenerative modification of Integrated Management Building should not affect the life and environmental quality of the people working in Integrated Management Building first. At the same time, it should also minimize the additional workload brought by the regeneration transformation to people.

The regenerative building transformation of Integrated Management Building not only did not affect the office environment of Integrated Management Building employees but also improved their work and life quality. Natural resources are used to the greatest extent effectively, becoming abundant material resources, which provides Integrated Management Building employees with the utmost convenience and pleasure in their work and life. The regenerative building transformation of Integrated Management Building also did not bring additional workload to employees due to the transformation. Treated waste is transformed into renewable resources, and employees, through the labor union activity, which is a regular activity that SAIC Volkswagen already has, create various items from it and circulate them to the reception center or office area, turning waste into treasure.

2. People currently working here are relatively satisfied with the current ecological environment. The core demand is the addition of some functional facilities and activities.

More regenerative modification can be considered within the ecological environment / functional facilities / activities.

By adding rainwater collection pavilions, the garden that originally only had ornamental functions is transformed into a renewable rain garden. Local green plants and flowers can be planted in the rain garden, and the ultimate beneficiaries are still Integrated Management Building employees. Because through the labor union activity, truly useful, valuable, and meaningful items are made, employees can not only relax physically after work, but also their hands-on ability is maximized.

3. For energy utilization, the recycling of water resources is the highest demand of people, followed by light energy.

Shanghai is a city with abundant rainfall, and it is humid in all seasons. People are prone to feel down on rainy days and think that rainy days are very bad. However, if rainwater can be utilized and become an indispensable resource for Integrated Management Building, employees' attitudes towards rainwater and rainy days will gradually change, and they will also feel that rain is a very meaningful thing.

4. In Integrated Management Building, the awareness and current situation of garbage classification have already had a certain foundation. The regenerative transformation can be combined with garbage classification to achieve the goal of resource recycling.

Indeed, in a new building like Integrated Management Building with complete functional facilities, there is already a good awareness of waste classification, but the recycled waste is still waste, not a resource. By contacting external waste treatment suppliers, the treated waste is transformed into valuable biomaterials.

5.5.2 Verification

Contemporary architecture no longer responds to rigid and predefined formal schemes, as classic buildings did, but to increasingly complex, diverse, and dynamic functional requirements related to social, energetic and environmental aspects. (Grisalena, 2020)

The regenerative building transformation of Integrated Management Building applies the theory of systemic design. Systemic design requires us not to view problems from a one-sided perspective but to place everything in context. Conduct an in-depth systemic analysis of the elements and environment of the design object, thoroughly understand the situation in which the design object is located and make targeted design for the design object based on this situation. This is the significance of systemic design. Systemic design is a comprehensive design method that emphasizes considering all aspects of the entire system during the design process, including environmental, social, economic, and technical factors. Since the carrier of the argument in this paper is SAIC Volkswagen Integrated Management Building, which is a comprehensive office building, the final effectiveness of the SAIC Volkswagen Integrated Management Building regenerative building transformation can be viewed from the following three aspects: 1. Office environment; 2. Ecological environment; 3. Employee satisfaction.

Firstly, the office environment mainly refers to the office space of employees. The main output is office consumables, which extend the service life of office consumables through maintenance, resale, or donation. The main input is recycled and reprocessed waste items, such as desks and work cards. From a long-term perspective, the office space for Integrated Management Building employees has become richer and more meaningful. Secondly, the ecological environment, whether it is the transformation from a garden to a rain garden or from a pond to an ecological pond, it is not difficult to see that the ecological environment of SAIC Volkswagen Integrated Management Building has been greatly improved. By adding rainwater collection pavilions and poultry, etc., the originally wasted rainwater resources are utilized to the greatest extent, and the products of the rain garden and ecological pond, such as green plants, flowers, and poultry eggs, can directly serve SAIC Volkswagen Integrated Management Building and ultimately benefit the employees of Integrated Management Building.

Under the intervention of systemic design theory, the Integrated Management Building regenerative building transformation has achieved a comprehensive upgrade in three dimensions.

When we introduced the concept of regenerative architecture in Chapter 2, we discussed that it encompasses "environment - ecology - resources" as well as "social - economic - natural" aspects. In terms of the "environment - ecology - resources" dimension, regenerative architecture is undoubtedly successful. It is greener, more environmentally friendly, and sustainable compared to traditional architectural design concepts, and it saves energy to the greatest extent and makes the most of its own resources. Looking from another dimension, the transformation of Integrated Management Building's regenerative architecture also meets the development requirements of "social - economic - natural." This is because regenerative architecture, under the auspices of systemic design philosophy, integrates the perspectives of these two dimensions in building design.

From the perspective of "environment - ecology - resources," regenerative architecture is undoubtedly successful. It is more green, environmentally friendly, and sustainable than traditional architectural design concepts, saving energy to the greatest extent and utilizing its own resources to the fullest. From another perspective, the transformation of Integrated Management Building's regenerative architecture also meets the development requirements of "social - economic - natural." This is because regenerative architecture, with the leading of the systemic design philosophy, integrates the viewpoints of these two dimensions in architectural design.

The summarized analysis results from Table 5 indicate that SAIC Volkswagen Integrated Management Building has successfully applied the principles of regenerative architecture.

In the office building, every space, every group, and the surrounding natural environment all have an interrelated relationship. This interdependent relationship reflects the concept of regenerative architecture, where the activities of each space and each group should not only reduce the negative impact on the SAIC Volkswagen Integrated Management Building environment but also actively promote the recovery and regeneration of the SAIC Volkswagen Integrated Management Building environment. Through this self-repairing and self-cycling approach, SAIC Volkswagen Integrated Management Building has demonstrated its potential and effectiveness in promoting ecological sustainability.

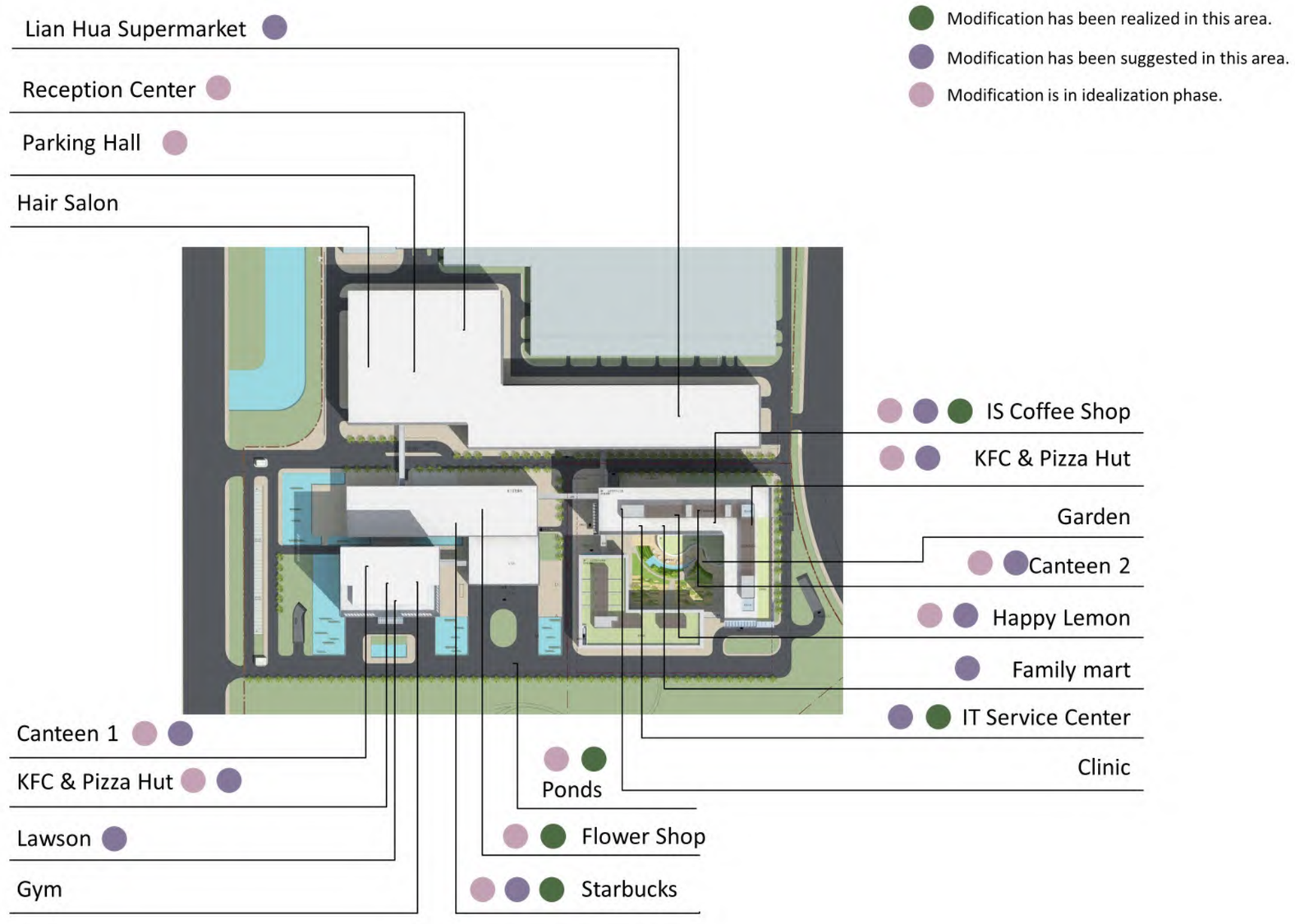


Figure 75 : Regenerative modification overview in integrated mangement building

Table 12 : Analysis of vernacular architecture against the nine principles of regenerative architecture (Littman, 2009)

	Indicators	Evidence
First Principle: The whole systems design integration	All systems and their elements are integrated into the whole system design.	Integrated Management Building not only focuses on the functionality and aesthetics of individual buildings but also emphasizes the harmonious coexistence with the surrounding environment and adaptability to climate conditions. The application of Integrated Management Building in the office buildings of the Jiading automotive industry demonstrates its leadership and innovation in promoting sustainable development and improving the quality of the built environment. Integrated Management Building has not only enhanced its own brand image but also set high standards and excellent examples for the entire industry.
	All systems are part of communities of mutually beneficial partnerships.	For example: Integrated Management Building utilizes rainwater resources to nourish the plants and organisms in the gardens and ponds. The green plants and poultry eggs can be transported to the canteen for employee use, and the products made by employees during labor union activities can be placed at the reception center as souvenirs.
	“Multiplicity” where each object inside the system should do more than one function or meet more than one demand.	Transforming into a regenerative architecture, Integrated Management Building has taken on multiple "identities," becoming more than just a single office building.
	“Redundancy” where each requirement in the system is addressed by more than one solution.	The office needs of Integrated Management Building employees, such as the types of office furniture and the friendliness of the office environment, are all met through a variety of solutions.

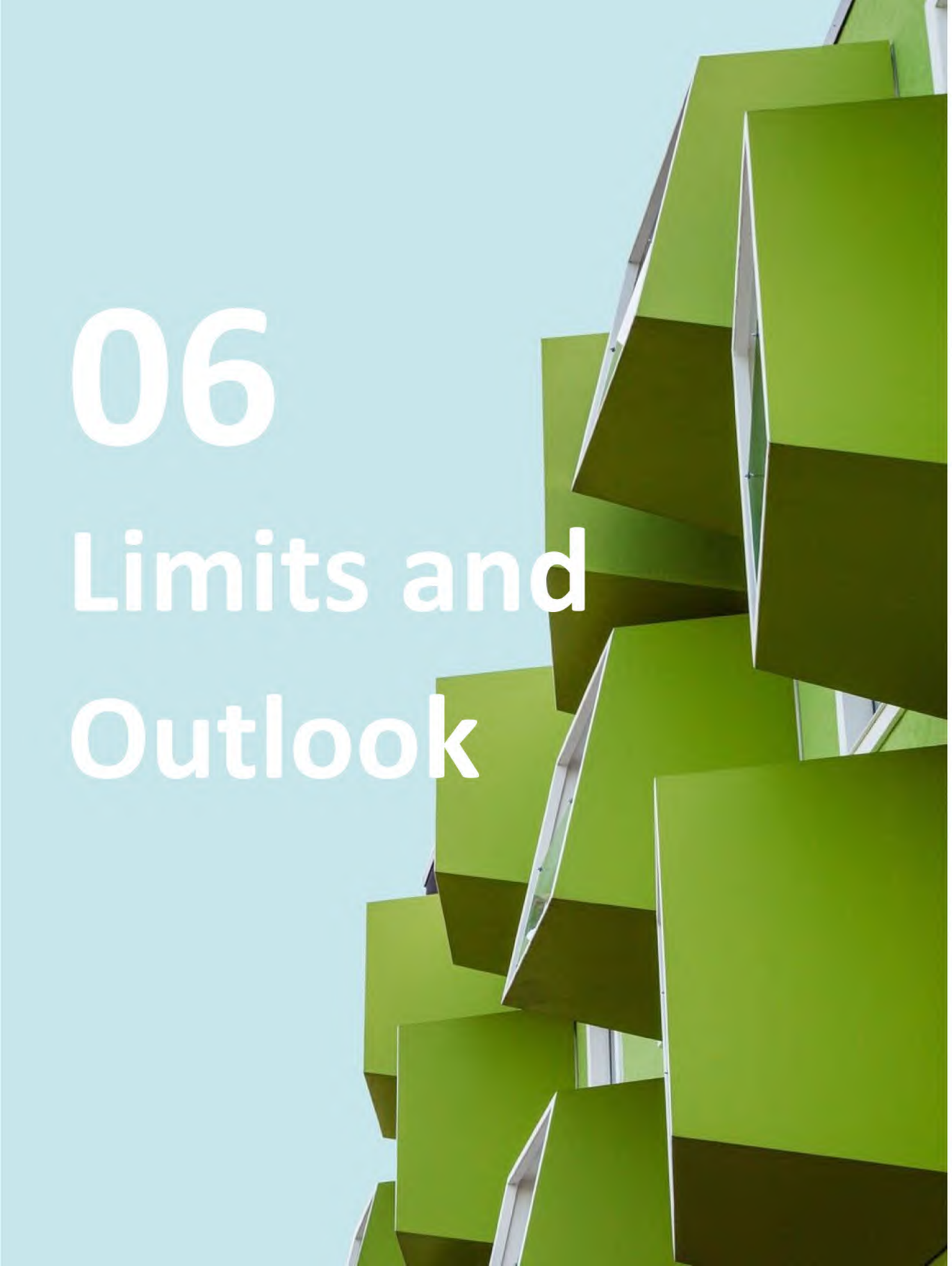
	Second Principle: Integration into the landscape	The natural elements are the generator of the design to create an artificially natural whole entity.	Integrated Management Building has made the most of the natural resource of rainwater, benefiting its gardens, ponds, and employees through a rooftop garden system, cooling system, and irrigation system. The existing solar energy utilization has also reduced Integrated Management Building's electricity usage to a certain extent, It not only improved the energy utilization efficiency of Integrated Management Building, but also contributed to the achievement of Integrated Management Building's environmental protection and sustainable development goals.
	Third Principle: Intelligent limits	Every program has a minimum needed limit and each material/space is effectively maximized and incorporated into the overall system.	The potential of every space and group within Integrated Management Building has been fully explored, providing more resources without changing the original needs. For example, the original garden only provided a viewing function for employees, but now they can also enjoy the vegetables and flowers grown in the rainwater garden.
	Fourth Principle: Concentration	Each space is necessary and preferred to be flexible.	The Integrated Management Building have become more flexible after the transformation of regenerative architecture. For example, the garden and pond are utilized in various ways by employees and other spaces.

Fifth Principle: Intelligent construction	The design utilizes natural and artificial methods and enhances material efficiency.		Integrated Management Building's rainwater garden and ecological pond make the most of rainwater as a natural resource, effectively integrating local natural environmental factors, and achieving the maximum regeneration and utilization of resources.
	Construction and materiality embody the architectural image.		Integrated Management Building is an Integrated Management Building located in the famous automotive industrial area of Shanghai. The original design used sloping lines and large areas of glass curtain walls to highlight the future sense of SAIC Volkswagen. However, in the transformation plan of regenerative architecture, the design of the rainwater collector for the Integrated Management Building garden is more flexible, which can be used to better showcase the architectural image of Integrated Management Building.
	Prefabrication/rapid prototyping		Rainwater collection systems are characterized by their design and material flexibility. This adaptability allows them to be tailored to various environments and requirements, enhancing their functionality and integration into different architectural settings.

Sixth Principle: Bold ecology	Ecological systems are regenerative and offer positive outcomes.	After the garden is upgraded into a rainwater garden, in addition to its ornamental functions, it can also grow local plants, flowers, and vegetables, which can be directly used in various spaces of Integrated Management Building. Similarly, the upgrade of the Integrated Management Building pond to an ecological pond will also yield positive results. This upgrade not only increases ecological value but also provides more possibilities for self-sufficiency within the building.
	Ecology incorporates all-natural factors as well as manmade elements.	The regenerative regeneration of Integrated Management Building has always been predicated on the use of natural resources. The recycling and reuse of natural resources is a win-win choice from both the perspective of the natural resources themselves and from Integrated Management Building's standpoint. Using sorted and recycled waste as biomaterial minimizes waste.
	Energy is transcendent.	Adopting passive design techniques has taken advantage of solar and rain energy and has minimized energy use.

		The scale has no impact on the significance of an entity/ group.	The premise of Integrated Management Building's regenerative architecture regeneration is to ensure that it does not affect the normal office work of Integrated Management Building's employees and other staff members.
Seventh Principle: Community	The design embodies sharing of knowledge and social activity.		The SAIC Volkswagen labor union activity is a highly efficient social activity, where Integrated Management Building employees require the guidance of professional instructors for the handcraft activities during the labor union activity. In the process of handcrafting, the knowledge of transforming waste into resources will be well disseminated to the Integrated Management Building employee.
	Every member of the community participates in and influences the design.		During the regenerative architecture transformation process of Integrated Management Building, every group is an important participant and actively engages in it. Integrated Management Building employees have participated in the process of turning biomaterials into more valuable products.

Eighth Principle: Experience of place	The place describes a story, creates a favorable experience, and is powered by a certain systemic form.	Integrated Management Building is no longer a simple office building, it is part of the natural and ecological environment, possessing a unique environmental image. Integrated Management Building employees not only enrich their leisure time in various labor union activities but also create new value and give new meaning to regenerative materials. The finished products made by hand, such as coffee cups and desks made from coffee grounds, can greatly enrich the office life of employees, making the monotonous office environment more interesting due to the presence of fresh items.
Ninth Principle: Culture	The history of the place and its Cultural resilience is accommodated, conserved, and presented in the design.	Although Integrated Management Building has not been established for a long time, SAIC Volkswagen has a history of 40 years to date, and VW has a century-long history. Integrated Management Building not only represents the image of SAIC Volkswagen as an Integrated Management Building but also stands as an outstanding representative, embodying the image of the entire Shanghai automotive industry. Integrating industrial architecture with the natural ecological environment organically, Integrated Management Building not only preserves the culture of the automotive industry but also reflects its outstanding philosophy in the ecological environment.



06

Limits and Outlook

Chapter Six concludes by describing the obstacles encountered during the entire design renovation process, as well as the author's reflections and outlook. As a large-scale company, SVW faced numerous challenges in the actual implementation of the renovation. However, the regenerative architecture transformation plan, which employs systemic design thinking, is correct and beneficial in the long term. It is believed that in the future, the method of systemic design will definitely be promoted to more architectural designs.

6.1 Limits

The limitations of this paper are mainly in the following aspects:

Questionnaire Survey

1) In the survey on the regeneration of IMB's regenerative construction, due to the limitations of the author as an ordinary employee, it is not possible to contact so many employees (samples), and there is not enough funding to support a large-scale survey activity at IMB. The survey sample only selected 100 copies, which is too small to represent the nearly 4000 employees of IMB. Moreover, the sample was not detailedly classified, ignoring the different ideas and viewpoints that may arise due to different job levels or professional fields.

Energy/Resource Consumption Analysis

2) In the process of analyzing IMB's actual energy consumption/resource consumption, detailed statistical data reports were not obtained. IMB's energy consumption reports are regularly analyzed and produced by a dedicated department, but due to confidentiality, they are not open to ordinary employees. Therefore, this part can only be obtained through the author's five years of experience and daily office observations.

Hardware Facilities

3) For ordinary employees, the instructions and operation processes for IMB's hardware facilities are not easily obtainable. For example, the rainwater garden on the 9th floor of the director's office building at IMB is not accessible to ordinary employees, so it is impossible to conduct research. The author can only consult with cleaning staff and director's secretaries on the 9th floor of IMB. However, because these employees are not professionals, the research on many hardware facilities of IMB is not comprehensive.

Organic Waste Recycling and Reuse

4) Regarding the recycling and reuse of organic waste, such as coffee grounds, although an agreement has been reached with the in-house café on the recycling of coffee grounds, and the union department has also carried out several activities, how to make it a long-term mechanism needs further discussion.

At the same time, the process of organic waste recycling and reuse requires the involvement of external resources. For example, the processing of organic waste and the recycling of discarded furniture, this aspect of work has been discussed with the company's relevant procurement and financial departments. The procurement and financial departments have negotiated with external suppliers for the processing of organic waste and the recycling of discarded furniture. SAIC Volkswagen determines suppliers according to its own pace and regulations, so this will be a long process.

Company Regulations and Articles

5) As we all know, SAIC Volkswagen Co., Ltd. is a joint venture enterprise, with both the organizational structure of German companies and the regulations of state-owned enterprises. Therefore, in the large organizational structure of SVW, any suggestion and measure need to involve many departments.

Among them, the transformation of IMB's hardware facilities will involve the main departments such as the enterprise operation department, planning department, financial department, procurement department, safety department, strategy

department, and union for joint discussion. At the same time, the transformation of hardware must be approved by the company's board of directors and local government departments. This move will inevitably require more manpower and resources, as well as time to be realized.

As a large enterprise, the most important goal of the enterprise is profit. For example, the rainwater irrigation system and insulation system, this transformation will inevitably require a lot of manpower and resources. At present, the upgrade and transformation plan for the rainwater irrigation system is only at the approval stage (the author has submitted rationalization suggestions, and the relevant departments have not yet reviewed). It is conservatively estimated that from approval to the actual implementation of the project, it will take two years or even longer.

6.2 Outlook

In systemic design, it is of great significance to incorporate systemic thinking from the very outset of the design process. Just for my research object, since it is an existing or already constructed architecture, inevitably, due to various objective factors, some excellent methods or ideas must be given up. Consequently, the systemic ideas or thoughts that can be put forward are rather limited. I hope that in the future, more regenerative architecture materials or technology will emerge to aid in the regenerative architectural modification of existing architectures. From the perspective of systemic design, these advanced materials and methods can also facilitate the implementation and improvement of the design. After all, in the face of environmental issues, both in China and globally at present, the modification and optimization of existing architectures is of utmost importance.

On the other hand, regenerative architectures place greater emphasis on the harmony and coexistence among people and architectures, as well as architectures and nature. The systemic design in this article mainly targets the environment and the utilization of various energies. Put differently, in the future transformation and optimization of the SAIC Volkswagen Integrated Management Building, the interrelationship between the Integrated Management Building and the surrounding enterprises in the industrial area can also be considered. For example, it could form a cycle with the factories or office architectures of the surrounding enterprises, complement and utilize each other, and enhance the communication and exchange between enterprises and among various architecture environments.

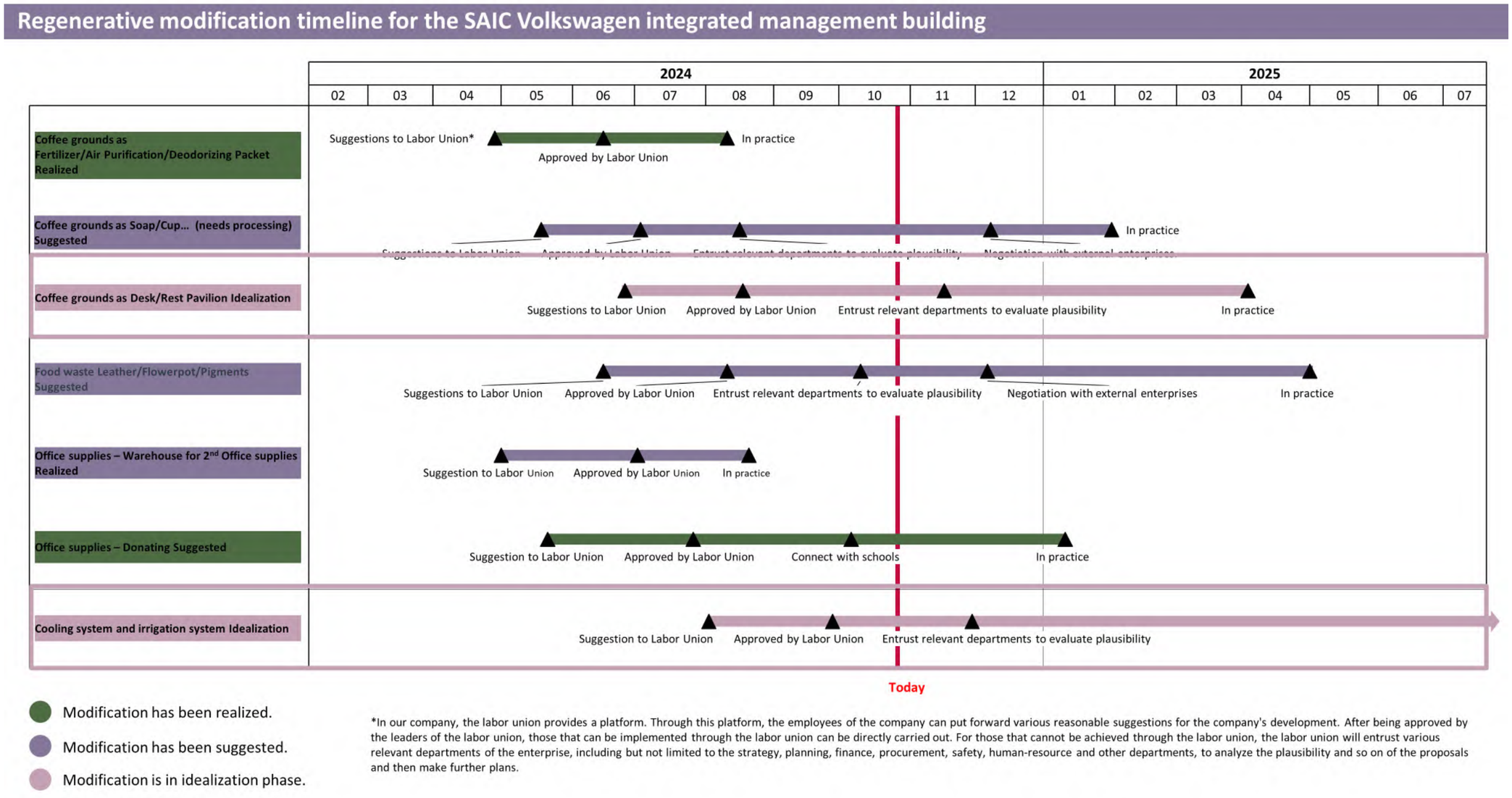


Figure 76 : IMB regenerative modification timeline

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