TROPICAL STRATEGY OF MODERN ARCHITECTURE IN CAMBODIA FOR THE DESIGN OF A CONTEMPORARY ART SPACE IN PHNOM PENH

Mr. Pisith Ty

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Architecture Program in Architectural Design
Faculty of Architecture
Chulalongkorn University
Academic Year 2017

กลยุทธ์การจัดการสภาพอากาศร้อนชื้นของสถาปัตยกรรมสมัยใหม่ในกัมพูชา เพื่อการออกแบบพื้นที่แสดงงานศิลปะ ร่วมสมัยในพนมเปญ

นายพิสิทธิ์ ไท

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสถาปัตยกรรมศาสตรมหาบัณฑิต
สาขาวิชาการออกแบบสถาปัตยกรรม
คณะสถาปัตยกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2560

Thesis Title	TROPICAL STRATEGY OF MODERN ARCHITECTURE IN CAMBODIA FOR THE DESIGN OF A CONTEMPORARY ART SPACE IN PHNOM PENH
By	Mr. Pisith Ty
Field of Study	Architectural Design
Thesis Advisor	Assistant Professor Rachaporn Choochuey, Ph.D.

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พิสิทธิ์ ไท : กลยุทธ์การจัดการสภาพอากาศร้อนชื้นของสถาปัตยกรรมสมัยใหม่ในกัมพูชาเพื่อการออกแบบพื้นที่แสดงงานศิลปะ ร่วมสมัยในพนมเปญ (TROPICAL STRATEGY OF MODERN ARCHITECTURE IN CAMBODIA FOR THE DESIGN OF A CONTEMPORARY ART SPACE IN PHNOM PENH) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร. รชพร ชูช่วย, หน้า.

ในทศวรรษที่ผ่านมาการก่อสร้างอาคารเติบโตอย่างรวดเร็วในประเทศกัมพูชา แต่อาคารหลายแห่งในจำนวนนี้ไม่ได้ออกแบบโดยใช้หลักการความยั่งยืน ปราศจากการคำนึงถึงสภาพภูมิอากาศเขตร้อน จึงทำให้มีการใช้พลังงานจากระบบปรับอากาศในระดับสูง อาคารที่ไม่ใช่อาคารพาณิชยกรรม เช่น สถาบันการศึกษาและวัฒนธรรมหลายแห่งไม่สามารถดำเนินงานได้ เนื่องจากขาดแคลนทุนทรัพย์สำหรับค่าไฟฟ้า เพื่อให้เกิดความเข้าใจในการออกแบบเสถาปัตยกรรมในภูมิอากาศเขตร้อนชื้นในกัมพูชา งานวิจัยชิ้นนี้จึงมุ่งเน้นไปถึงการศึกษางานของนายวานน์ โมลีวานน์ บิดาแห่งสถาปนิกในประเทศกัมพูชา ผู้เป็นสถาปนิกหลักของรัฐบาลกัมพูชาในช่วงทศวรรษ 1960 ก่อสร้างอาคารสมัยใหม่อันเป็นอาคารสาธารณะสำคัญๆ ของรัฐหลายแห่งหลังจากได้รับเอกราช การวิเคราะห์องค์ประกอบทางสถาปัตยกรรมเพื่อให้เข้าใจถึงกลยุทธ์ในการออกแบบสถาปัตยกรรมสมัยใหม่ ภายใต้ความท้าทายของสภาพภูมิกาศร้อนชื้น ในช่วงเวลาที่ระบบปรับอากาศและเทคโนโลยีการก่อสร้างทิก้าวหน้ายังไม่แพร่หลาย โดยใช้อาคารจำนวน 13 แห่งของวานน์ โมลีวานน์ที่ยังสามารถเข้าไปเยี่ยมชม หรือมีเอกสารต่างๆ ที่ยังสามารถใช้ศึกษาได้อย่างเพียงพอ สรุปเป็นเกณฑ์ที่ใช้เป็นแนวทางสำหรับงานออกแบบสถาปัตยกรรมที่ใช้เทคโนโลยีแบบยั่งยืนสำหรับภูมิอากาศในกัมพูชา โดยเกณฑ์ที่ได้จากการศึกษากลยุทธ์ในการออกแบบสถาปัตยกรรมในเขตร้อนชื้นนี้ จะถูกนำไปใช้ในการออกแบบ อาคารสำหรับศิลปะร่วมสมัย ในย่านงานศิลป์ของกรุงพนมเปญ

สาขาวิชา การออกแบบสถาปัตยกรรม ลายมือชื่อนิสิต .....

ปีการศึกษา 2560 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

5973701525 : MAJOR ARCHITECTURAL DESIGN
KEYWORDS: TROPICAL STRATEGY / TROPICAL SUSTAINABILITY / MODERN KHMER ARCHITECTURE / TROPICAL ARCHITECTURE / SOUTHEAST ASIAN ARCHITECTURE / MODERN ARCHITECTURE IN SOUTHEAST ASIA / VANN MOLYVANN / AIR-CONDITIONING

PISITH TY: TROPICAL STRATEGY OF MODERN ARCHITECTURE IN CAMBODIA FOR THE DESIGN OF A CONTEMPORARY ART SPACE IN PHNOM PENH. ADVISOR: ASST. PROF. RACHAPORN CHOOCHUEY, Ph.D., pp.

In the past decades, Cambodia has experienced a boom in building construction. However, many of those buildings do not take sustainable approach into account. They are built without concern of the tropical climate which results into a high level of energy consumption from air-conditioning system. Some none-commercial buildings, such as cultural and educational facilities, could not be operated because of lack of the fund for electricity. For a better understanding of architectural design in the tropical environment of the context, the research focuses on the works of Vann Molyvann, the father of architects in Cambodia, a state architect in 1960s, who was active constructing the major Cambodian modern public buildings after the independency. His tropical design strategy dealing with weather challenges, when air conditioning and other advanced technology was rarely available, would be investigated through thirteen buildings that still exist and are accessible or carry sufficient documents for the study. The investigation of the architectural elements would be analysed and summarised as a design guideline for sustainable technological architectural design for the climate of Cambodia. Subsequently a contemporary art space will be designed in the site of art district in Phnom Penh by applying the guidelines of tropical strategy from the study.

Field of Study: Architectural Design Student's Signature .....

Academic Year: 2017 Advisor's Signature .....

ACKNOWLEDGEMENTS

First of all, I would like to express my deepest gratitude to my thesis advisor, Assist. Prof. Rachaporn Choochuey, Ph.D. for her patience, motivation, enthusiasm, immense knowledge and her guidance with expert suggestions that helped me in all the time of research and writing of this thesis. It is impossible to be accomplish this thesis without her supports.

I would like to show my sincere appreciations to chairman of Master of Architecture, international program, Assoc. Prof. Pinraj Khanjanusthiti, as well as committee members, Assist. Pro. Pirasri Povatong, Ph.D. and Chomchon Fusinpaiboon, Ph.D for their valuable comments and excellent teachings throughout my master study and toward the completion of thesis. I am grateful to the external examiner, Dr Roger Nelson, Postdoctoral Fellow. for his valuable time, spent his expertise on reading my thesis and giving me excellent comments. I would like to extend my thanks to all of professors and office coordinators in Faculty of Architecture, Chulalongkorn University.

Lastly, my endless gratitude goes to my beloved parents and my sister for their love, encouragements and care. I would also like to thank to all of my friends in M.Arch. program Ms. Khaisin Lee, Ms. Pearl Thitsar and special thank to Ms. Hang Sotheavy and Ms. Malin Phlernjai who always to be my side, listening support and giving a positive energy in my pursuit studying, without their kind support and assistance during the study period of Chulalongkorn University, I would not have succeeded.

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CHAPTER 1 INTRODUCTION

1.1 Problem Statement and Research Significance

Cambodia is one of the countries whose cities have been developing at an extremely rapid pace (Fig. 1). Architectural design is one of the most pressurizing issues that has a huge impact on its inhabitants' well-being. Many buildings are failing the test of sustainability due to the action of unforeseen factors. One of the greatest concerns is the constant call for the incorporation of air conditioning systems in many buildings, as architects' lack the knowledge of dealing with the country's tropical climate (Fig. 2). Air conditioning systems are expensive to install and even more expensive to operate, as they consume a significant amount of energy. Hence, they do not represent a very sustainable alternative for a country like Cambodia. In particular, many contemporary non-commercial public buildings are struggling to function, or some can operate only partly due to the lack of funding to pay for the buildings' electricity supply. These buildings are mainly educational or cultural centers that are extremely important to the country's future citizens (Fig. 3). The issue is rather alarming when its consequences are considered the long term.

In order to identify proper strategies to deal with tropical climate through modern architecture, we need to explore the modern architecture of late 1960's, a period when air conditioning systems were not widely used. Most buildings of that had to be sustainable by default due to the limited technology available at that time. Buildings were built without the use of advanced mechanical systems. Moreover, architects had to be more sophisticated dealing with the climatic conditions, for instance, a wide temperature range, cold and hot winds, and several other natural influences.

This study investigated the methodology of Vann Molyvann, the renowned father of modern architecture in Cambodia. It aimed to understand his architectural strategy that would fight the adverse extremes of tropical climate. The strategy was summarized into architectural elements and composed into several guidelines. Subsequently, the guidelines were finally applied into a design of a new contemporary

art space in Cambodia, which presented an instance of a big cultural public facility that may lack resources to run an air conditioning system.

Figure 1. 1 Phnom Penh city of Cambodia 2017 (Source: INQUIRER.NET)

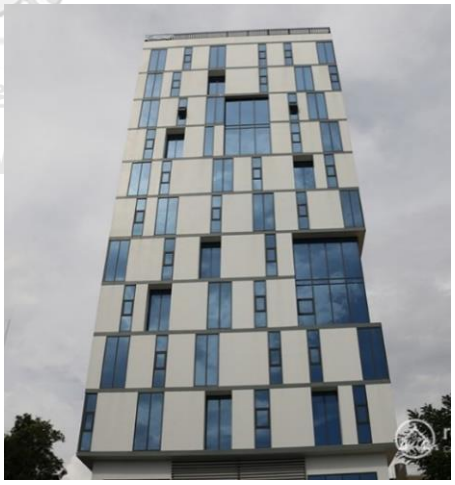


Figure 1. 2 Apartment and City tower office rental space in Phnom Penh (Source: MLS Cambodia)

Figure 1. 3 Romeet Contemporary art space in Phnom Penh (Source: Romeet Gallery)

1.2 Purpose of Study

The primary purpose of this thesis is to explore architectural strategies to deal with tropical climate in contemporary Cambodian architecture, which employ a low level of technology and offer sustainability. The requisite tropical strategy could be learned by examining the work of the master of modern architecture in Cambodia, Vann Molyvann; he invented viable strategies, incorporating natural cooling features in his designs, suitable for tropical climate, eliminating the need for excessive dependence on air conditioning systems.

1.3 Scope of Study

A study of modern architecture in the 1960's, when air conditioning systems were not widely applied, could help in developing strategies to address tropical climatic conditions through architectural designs. Architects of the time had to be extra careful in dealing with the weather and several other environmental effects. Vann Molyvann presented the best example in this regard in Cambodia. His strategy to deal with the climatic situation in the country involved sensible solutions with limited use of technology, while accommodating the cultural context. Vann Molyvann showed to

the people of his country that it was possible to deal with the tropical conditions through his works, with the language of modern architecture and lifestyle.

The research focuses on the design analysis of modern buildings from the period in which air conditioning systems were not widely used, the 1960s New Khmer Modern Architecture of Vann Molyvann, and investigates the architectural elements of this style, such as roofs, walls, openings, and other features that deal with the tropical climate conditions efficiently. The Vann Molyvann's projects selected for this study will be both public and private buildings that contain sufficient information to demonstrate the features that address the strategy. There are limited but rigorous researches on Vann Molyvann's works, however most of the researches focus on the architectural design ideas related to social and cultural contexts, not the climate. The study, therefore, focuses only the aspects of how his buildings deal with the tropical climate successfully with limited building technology. The study did not examine the cultural and political aspects pertaining to Vann Molyvann's New Khmer modern architecture.

Finally, a contemporary art space in Cambodia was be selected for the design application of the tropical strategy learned from the master's works in the last part of the thesis. To gain further understanding of modern Cambodian art spaces, the study covered the art spaces in several cities across the country. A comparison of Cambodian and Thai art spaces in terms of design, including accessibility, art space control, support facilities, and services, was conducted to gain further understanding.

1.4 Research Methodology

This study used literature reviews, on-site observations, interviews, case studies, and analysis of existing Vann Molyvann's buildings. Both drawings and texts were utilized on the cases in order to understand the issues surrounding Vann Molyvann's principle strategy concerning the built environment and climate factors that form modern Cambodian architecture. Existing and non-existing architectural designs were studied to determine the advantageous and disadvantageous strategies, which served as guidelines for designing contemporary structures suitable for tropical climate, which

did not demand much mechanical air conditioning. The information collected was analyzed and summarized into a strategy, a set of guidelines.

First, the art spaces in Cambodia in the cities of Phnom Penh, Siem Reap, and Battambang were examined with the same methodology as that used for Vann Molyvann's works. In order to gain a comprehensive insight concerning the state of contemporary art, Thailand was also be included in the discussion, due to the similarities between Cambodian and Thai art. The reviewed case studies will be analyzed and represented diagrammatically in order to formulate an optimum design for architecture in tropical climate.

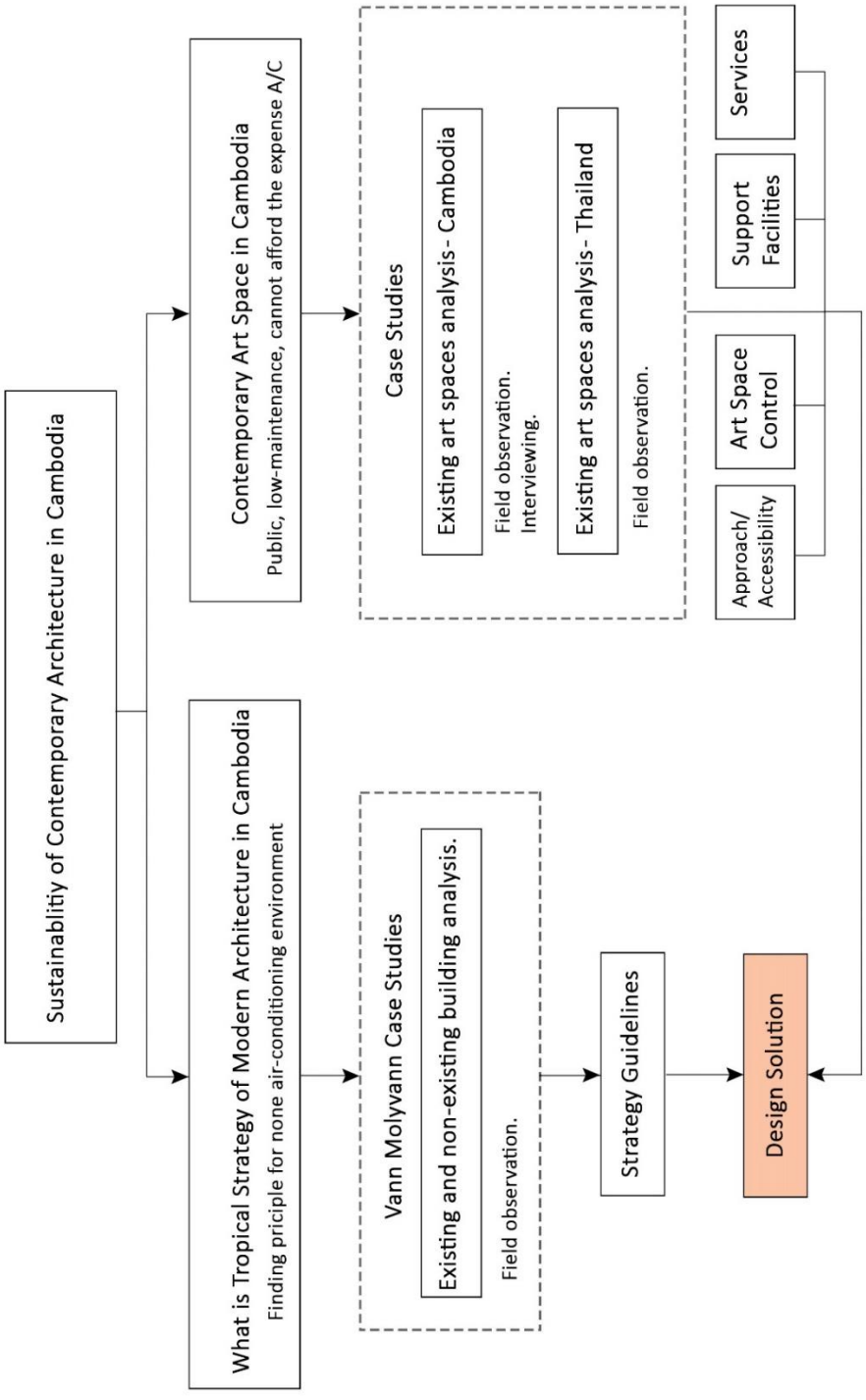


Figure 1. 4 Diagram summary of thesis structure

1.5 Benefit of Study

The main contribution of this thesis will be offering suitable tropical strategies for contemporary architecture in Cambodia. It is hoped that the guidelines provided by this thesis will be beneficial with regard to more economic and efficient designs in the future, which can moderate the cost of air conditioning at least, not only for Cambodia, but for other regions with tropical climate as well.

CHAPTER 2 MODERN ARCHITECTURE IN CAMBODIA AND TROPICAL STRATEGY

Modern Khmer architecture has its roots in Cambodia's traditional culture. The declaration of Cambodia's independence in 1953 by King Norodom allowed the adoption of modern Khmer architectural styles in designs. It entails a combination of both traditional Khmer cultural and modernist influence. It did not only lead to the creation of aesthetically pleasing and highly innovative artworks but also acted as an essential element in Cambodia's national buildings.

2.1 Introduction of Modern Architecture in Cambodia 1960s

Figure 2. 1 Institute of Foreign Languages library. (source: Stephen Brookes)

Although the term Modern Khmer is associated with modernist architecture movements, its origin lies in traditional and ancient Khmer styles as well as colonial European heritage. After Cambodia's independence, King Norodom Sihanouk focused on modernizing Cambodia. Thus, he brought together both international and Cambodian architects and experts to help enhance the country's infrastructure. Public buildings were constructed all across the Kingdom to support the various sectors.

Although trained in France, the young Cambodian architects tried to incorporate modern architecture with the traditional style. They borrowed various aspects of critical thinking that were applied in the construction of post-war Paris. The training enabled them to combine traditional Khmer elements with modern architectural designs. Given that the previously used designs and architectural styles were borrowed from Europe, the styles did not consider the climate of Cambodia that always remains hot and humid.

Modern Khmer architecture successfully combined elements of Cambodian culture and modern and tropical designs to create designs that could withstand the prevailing climatic and environmental conditions (Ross & Collins, 2006). Vann Molyvann was one such Cambodian architect who pioneered the adoption of such techniques in design.

2.1.2 The Founding Father of Modern Khmer Architecture

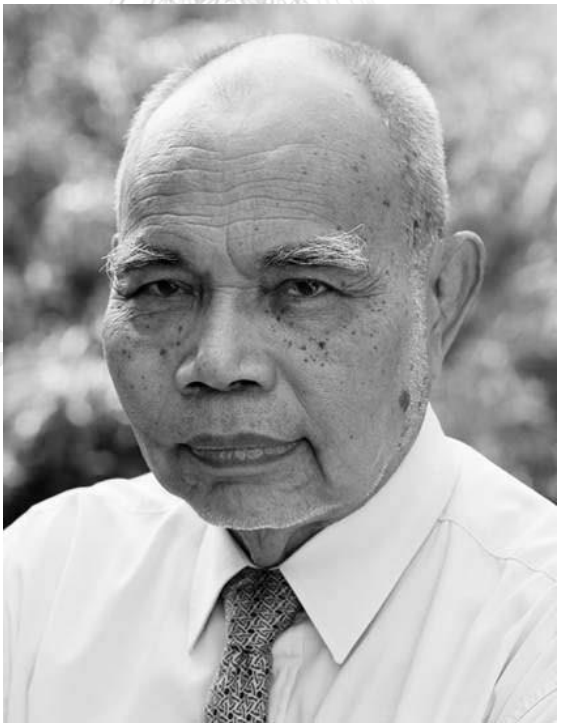


Figure 2. 2 Father of modern architecture of Cambodia architect 'Vann Molyvann' (Source: Nikolas Koenig)

Van Molyvann was born in 1920 in Kampot province (Fig. 2. 2). In 1946, he received a scholarship to pursue architecture in France, after pursuing which he returned to Cambodia. The state had just gained independence from French colonial rule. With his natural talent, Vann Molyvann was designated as Cambodia's state architect and head of public works by King Norodom Sihanouk for helping him create a 'New Cambodia'. Vann Molyvann was responsible for large-scale architecture and urban design projects, which gave him an opportunity to exhibit his skills and capability. Over a short period 15 years (1955–1970), Vann Molyvann initiated the designing of these projects and constructed more than 100 buildings to render grandeur to Cambodia's transition from an agrarian society to a modern state. Vann Molyvann designed many of Cambodia's most aspiring and well-known public and private projects, such as government offices, commercial structures, schools and university buildings, exhibition and conference halls, airports, train stations, cinemas, national theatres, social housing projects, all of which were constructed across the country under the modernization movement proclaimed by Sihanouk's Sangkum Reastr Niyum (People's Socialist Community) regime (Bodach Susanne, 2017).

2.1.3 Famous Architectural Designs

A few of Vann's most famous public works, which were built to sustain the tropical climate of the region, included The National Sports Complex, designed in 1964 (Bodach Susanne, 2017), the Teachers' Training College, which contains bio-climatic features, including cross ventilation and indirect lighting, the Chaktomuk Conference Hall, State Palace, and lastly, the Olympic Village apartment, the Preah Smart National Theatre, Sangkum Reastr Niyum Exhibition Hall, which is a part of the Bassac Riverfront Project, a concentrated public urban development flagship project located on the reclaimed land of the Tonle Sap river (Ross & Collins, 2006).

2.1.4 Literature Review

Prior to this research, limited research was conducted concerning Vann Molyvann. There are many political, cultural, and architectural influences on the Vann Molyvann's architectural style.

According to Collins, Van Molyvann was a widely known exponent of a method that was applied nationwide, trying to find a new identity for his country with a new style of architecture, known as New Khmer architecture. In both urban and rural areas, a unique approach was used to deal with the challenges and opportunities presented by postcolonial constructions that were prominent across the country after its independence from France in 1953. He spearheaded the wave of creativity and reinvention as the state architect. Apart from drawing on from these pre-existing forms, his architecture included various kinds of modern influences from Japan, the U. S., and Europe (Collins, 2012).

Further, Ross and Collins indicate that the New Khmer Architecture is perceived as a mixture of the ancient tenets of Cambodian culture that drew elements from the austere style of modern architect Le Corbusier. Therefore, it became a vernacular, comprising the influence of international modernism and negotiation between many design sources, for example, and local circumstances (Ross & Collins, 2006). Van Molyvann drew inspiration from the Angkor Era designs for structures such as the Independence Monument, which resembles the shape of a lotus flower (Molyvann, 2002). Further, Collins contends that the building was inspired by the Arc de Triomphe and showcases the rich Cambodian culture since it is often focused on religious and political actions. It is also a popular tourist destination that attracts Phnom Penh residents as well (Collins, 2012).

In accordance with Wong, Molyvann greatly influenced his era, which is referred to as the Golden Age, through the construction of cultural facilities such as the National Theatre Preah Suramit. Further, Matsubara demonstrates that these buildings promoted the preservation of Cambodian culture and traditions through the inclusion of wooden building materials that existed during the Khmer dynasty and motifs based

on the stone culture of Angkor Wat. These structures had wooden roofs placed over frames with high floors reinforced by concrete pillars (Wong, 2011).

Additionally, Molyvann states that the architect was much inspired by natural elements, such as water and wind, also an influence which can be observed in his works. An example was the national theatre that resembled a great ship, as he spearheaded the restoration of temples at Angkor Wat. Furthermore, Nelson argues that the National Sports Complex had pools around it that imitated the moats surrounding Angkor Wat. The various works that he developed cleverly synchronized Khmer culture with western elements in a smart manner.

According to Nelson, even though Van Molyvann's architectural style drew inspiration from the Angkor era, the structures were constructed with modern materials such as concrete. This style made his works the Giant Cantilever and the National Sports Complex popular across the world (Nelson, 2017). He also referred to older Cambodian construction styles for the creation of buildings, both at the aesthetic and structural levels, for instance, the feature of elevating structures on stilts. Nature was another salient feature represented in his buildings, for instance, he incorporated elements of tropical climate, such as natural airflow and shade. The Angkorian temple decorations were used sparingly, serving mainly as bas-reliefs. Wong asserts that while constructing the buildings, he designed the structures so that they allowed abundant natural light and ventilation and could resist the extreme climatic conditions. An example is the pools that were designed to protect the National Sports Complex from the Monsoon winds (Wong, 2011) .

In particular, most of the researchers have focused their efforts on the cultural, political, and technical aspects of Vann Molyvann architectural style. More specifically, the objective of this research is to analyze the architectural work concerning the characteristics they share as possible strategies to make building with the ability to maintain sustainability in a tropical climate while providing a comfortable environment to the inhabitants. At the same time, it is important to understand the remarkable designs to demonstrate how Vann Molyvann incorporate features such as natural ventilation, and natural sunlight entry to the structures compared to the modern techniques. Therefore, the discussion provides examples that can be exploited for

contemporary architecture for development of better and sustainable buildings for the country and the region at large.

2.1.5 Tropical Climate and Tropical Architecture

Tropical climate signifies moderately high levels of heat, with temperatures potentially exceeding 30 degrees. The region also experiences hot seasons, since the temperature mostly remains around 20 degrees. The characteristics of tropical climatic conditions include high humidity levels, with the relative humidity ranging from 50%–100%. The wind conditions majorly comprise slow wind flows. The area is also dominated by alternating dry and wet seasons.

Cambodia is a tropical climatic region, with a consistently high temperature range from 21 °C–35 °C; two seasons are recognized: monsoon-driven rainy season (May–October), when moist air between 80–90% is drawn landward from the ocean, bringing the southwest monsoon rains to Cambodia. During the dry season (November–April), the air pressure rises, driving the cool dry air back, and bringing a largely rainless season to the region (GROUP, 2011). Hence, the country faces a number of climatic challenges. In such case, buildings should be built to reduce or avoid the problems presented by these climatic changes. Modern Khmer architectural designs incorporated styles that were suited to the tropical climate. Examples of these architectural aspects included north-facing buildings to enable cooling from the large forests. Orientation toward the north was particularly important for these structures, as it shielded the corridors from direct sunlight, hence buffering the inner rooms. Raising the buildings a few meters off the ground provided perfect aeration that cooled the area below the floors and reduced damage during floods. Structures were built with elongated ceilings to allow ventilation in rooms. They also protect the occupants from excessive humidity. Most of these buildings were environment-responsive due to the dynamic environmental changes prevalent in this area.

2.1.6 Sustainable Development

As stated earlier, Cambodia experiences dynamic climatic changes throughout the year. Therefore, it was important to build structures that were comfortable across the alternating dry and wet seasons. Currently, electronic air conditioners are widely used to control indoor climate. However, in the 1960's, this technology was not common in Cambodia. Instead, architects of that time began to introduce alterations in significant ways by inventing and applying modern construction techniques in their architectural designs to facilitate indoor comfort.

In contemporary times, discussions pertaining to energy conservation are quite common and are increasing in most urban contexts. Some other 'greener' strategies, such as vegetation around buildings to counter excessive heat and humidity, are also being introduced to encourage sustainable infrastructural development (Lewis, 2016). Sustainable development is not only taking place in Cambodia but in other states experiencing adverse climatic changes as well. In this regard, Vann Molyvann's designs are extremely valuable as they offers sustainable approaches to architectural designing.

2.2 Documentations and analysis of Vann Molyvann's Architecture

This thesis examines 13 buildings, explaining the concept of designs that facilitate buildings' usability in the tropics, using Vann Molyvann's design ideas. A total of 10 buildings are from Phnom Penh and three from the Sihanoukville province. The objective of selecting these buildings is to analyze the design features that render them usable in spite of the difficult environmental conditions, such as high temperature and high humidity, offering the residents shelter from the changing climatic conditions in Cambodia.

2.2.1 Criteria of Choosing the Buildings

Buildings without air conditioning. A major criterion that will be employed in the selection of buildings for analysis will be the focus on Vann Molyvann's architectural works. Both his private and public works will be selected for analysis as a means to

enable temperature and humidity regulation without the use of air conditioning systems. A total of 13 case studies were conducted for the existing buildings in various provinces in Cambodia. Buildings with data sufficient for analysis were used to understand the strategy used by Vann Molyvann to promote air circulation and regulation of temperature, humidity, and other environmental conditions that affect the buildings use. The selected buildings are those without mechanical air conditioning systems, since the focus of this analysis is to determine how buildings design can help limit the use of air conditioning systems.

Architectural drawings. Architectural drawings with features that would enable temperature and humidity regulation and air circulation were used to select the buildings for analysis. Some buildings may not be in existence, but their drawings can be interpreted to gain insight regarding how the designer intended to achieve better air circulation, temperature and humidity regulation using the buildings' physical components.

Accessibility. Accessibility of information regarding the buildings of interest will be used as a determining factor for the selection of buildings: the buildings whose records can be obtained even if they do not exist will be used. The accessibility of historical information will be useful in gaining insight regarding buildings' physical characteristics that render them suitable with regard to their usability during high temperatures and humidity, with reduced reliance on air conditioning systems. In this regard, information sources such as architectural drawings will be useful for knowing the features that make buildings unique for occupation in Cambodia's tropical climate. Any data regarding buildings will also be useful for making decisions for designing the environment in which buildings are constructed in Cambodia for improved sustainability.

Physical model. Buildings whose physical models are in existence will be selected for analysis, even if the physical buildings have been demolished. Drawings of buildings

will be important because they can be analyzed for more information pertaining to design and other features.

The 13 buildings:

2.2.2 SKD Brewery

Figure 2. 3 SKD Brewery office in Sihanoukville (taken by author, 05 November 2017)

Vann Molyvann designed the SKD Brewery in the year 1966 as a result of a government-issued contract. He was provided a contract to create buildings plan for the government offices and the brewery. The government offered Vann the commission to design the company, thus he became the organization's sole planner. The contract did not go beyond the structures of the office buildings and brewery. Therefore, he was expected to create a design that would be sufficiently spacious to accommodate all of the company's intended utilities. Furthermore, Vann was required to estimate the cost of construction based on all required resources, from materials,

machinery, to human labor. The organization became operational in the year 1968, even though during the cold war, it was forced to cease operations, until the year 1991 (Ross & Collins, 2006).

Currently, the company produces Angkor beer, highly popular in Cambodia (indicated by its large market share in the country). The building has undergone renovation and its exteriors have been painted in red and white. Vann's design was concrete, meaning that the buildings are sustainable and little needs to be done to continually make them habitable for humans (Fig. 2. 3).

Vann designed a two-story construction for the offices opposite to the main gate. The other storied building contains a dramatic cantilevering, supported by the six-meter external trusses. Further, the offices resemble the Khmer homes because of their stilts, which helps maintain a cool atmosphere (against the tropical heat) and protects the offices from floods due to heavy rains (Ross & Collins, 2006) (Fig. 2. 4). Additionally, the stilts allow aeration in the building and also serve as a parking space for the people working in or visiting the organization (Fig. 2. 5). The first floor of the offices contain windows between the double walls, which allow further aeration, light, and a view of the surroundings. Red bricks have been used for the wall on the outside, with a gap between the internal concrete wall to allow air passage to reduce heat (Fig. 2. 6, 2. 7).

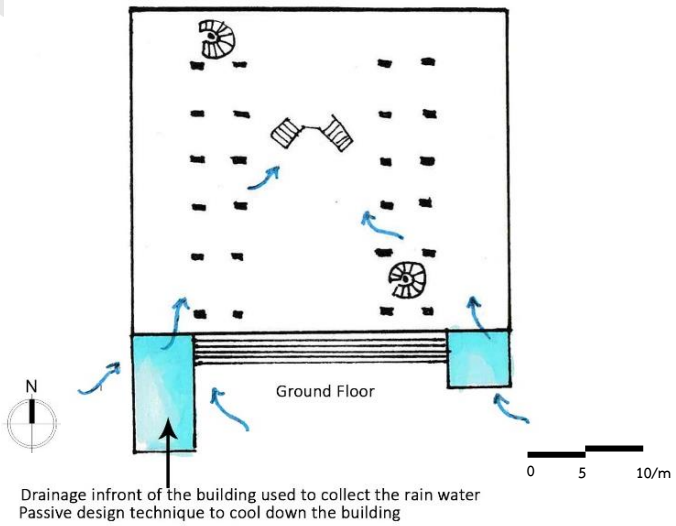


Figure 2. 4 Diagram drawing analysis ground floor plan of SKD Brewery office

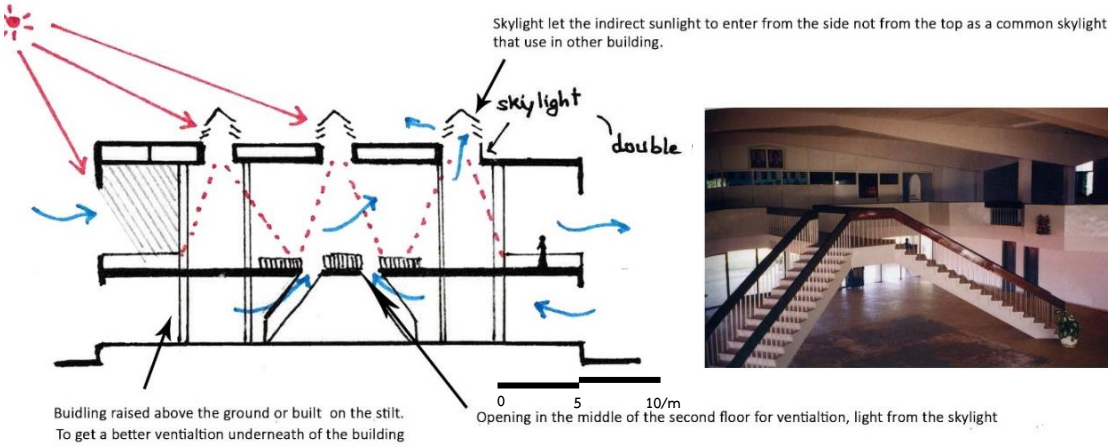


Figure 2. 5 Section diagram of the building showing, raised ground level to facilitate ventilation and allow a multipurpose space beneath the building. (source: New Khmer Architecture Book)

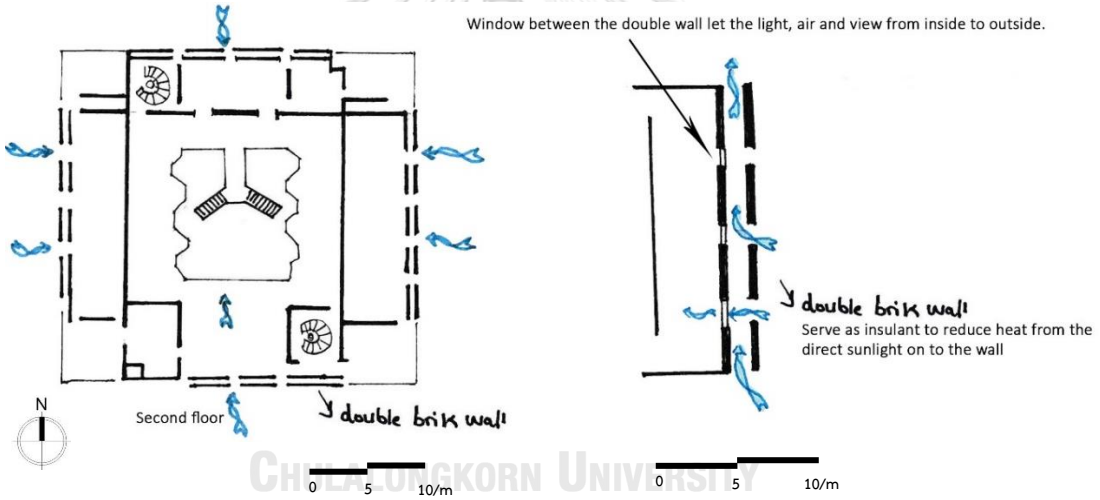


Figure 2. 6 Diagram drawing analysis of windows between double walls to allow light, air, and a view of the outside

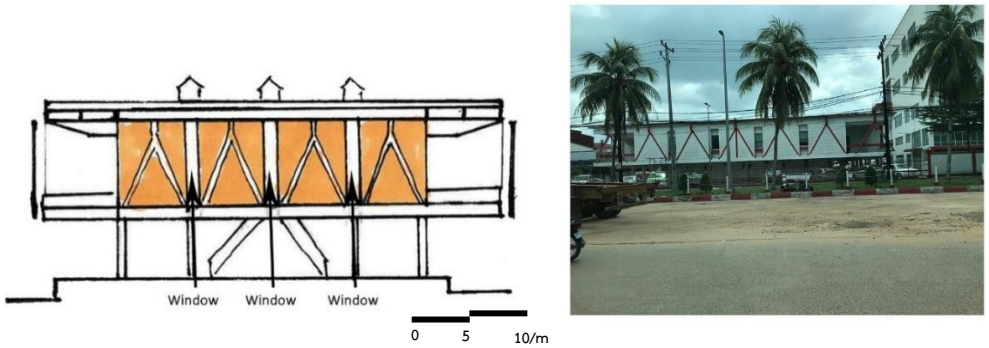


Figure 2. 7 Diagram drawing and photo displaying the vertical windows of the west elevation

The building has a double roof, the space between the roofs acts as an insulator, thus minimizing the heat from the sunlight entering the building (Fig. 2. 8). Additionally, the buildings were designed to allow sunlight penetrate the building from the side (Fig. 2. 9). The office buildings comprise various unique features, such as spiral staircases and floating boxes, rendering it extremely attractive.

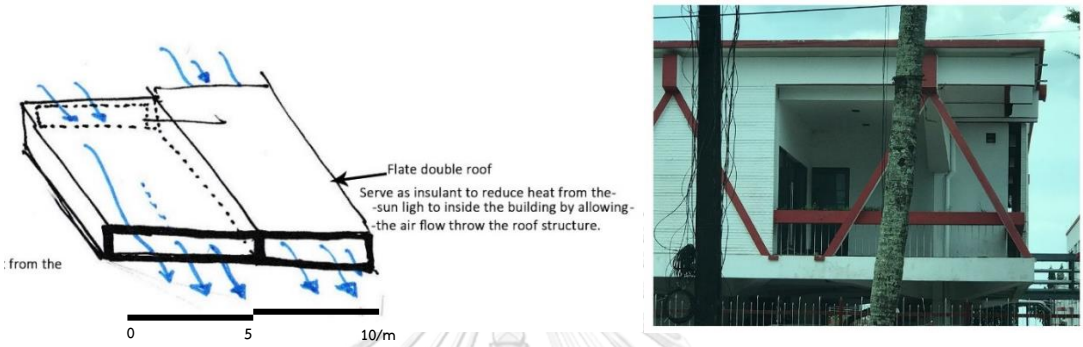


Figure 2. 8 Flat double roof design with the two-layer structure that serves as an insulation, reducing the heat caused due to the sunlight

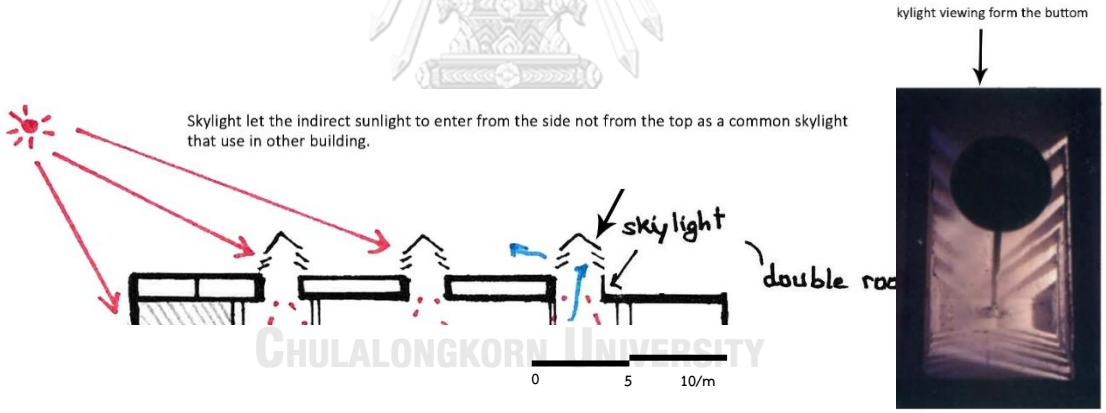


Figure 2. 9 The sky light allows indirect sunlight to enter from the side louver. (source: New Khmer Architecture Book)

The brewery factory constructions were covered with a gable roof, which lends them a simple appearance. The site planning for the whole project was done for beer production. The designing for the whole company was executed to prevent any drainage issues in the facility. The compound contains trenches that are always kept clean to allow smooth water flow. The company has an intact sewage system, so the fluid wastes from the brewery and the offices are not discharged into the environment.

Further, the designer ensured that the buildings were equipped for rainwater harvesting with the rooftops on the front. The company was constructed on land that is slightly slanted, allowing easy water flow. Conversely, with regard to the cantilevering, a low-ceilinged space stand beneath the cantilevers, and the spiral staircases lead to the base of the upper flow.

However, the double roofing system poses some challenges that include difficulty in cleaning the spaces in between the double roof structure because of the small spaces rendering the trapped dust and substances inaccessible. Moreover, other substances trapped such as grass and leaves provide ideal conditions for birds to live in there. Consequently, the flow of air will be compromised hence the brewery temperatures are not regulated well and becomes hot.

SKD brewery successfully incorporated the drainage pool to contain the wastewater and materials. However, since the sewerage system trenches are open, they become prone to attacks by algae and moss providing the best conditions for mosquitos to breed and disturb the users. Also, the open trenches provide a health risk to people in the nearby environment especially the children who might fall into the drainage pool and sustain serious injuries. The waste space is also significant in achieving the much-needed cooling for the building. As a result, this space should be big enough in scale to facilitate total cooling of the plant.

2.2.3 The Central Bank Branch in Sihanoukville

Figure 2. 10 The main entrance and the backside of the Central Bank branch in Sihanoukville (taken by the author on November 5, 2017)

The Central Bank branch in Sihanoukville was designed in the 1960's. During this period, Cambodia's paper currency was printed in France and then transported to the country via ships. Hence, the bank was constructed near the harbor to minimize the risks of robbery and fraud. Therefore, the construction's aim was to serve as a central distribution center for Cambodian currency after its arrival from France. Further, the other aim of the building was to provide banking services to people living in its vicinity, facilitating saving in and borrowing from the organization. Residential houses were also built for the senior employees. The design contains other staff buildings that were supposed to be occupied by willing workers of the organization. Additionally, there was an incinerator for destroying the currency that could not be put back into circulation, because it was either worn or fake. Thus, the aim of the building was to stabilize the economy by controlling inflation (Ross & Collins, 2006) (Fig. 2. 10)

The banking structure comprises a two-story building with a safe meant for the money in the first major hall. The staff offices are located on the second floor. Due to the terrain, the bank was constructed such that in the east, the first flow would be at the level of the ground. The side facing the sea receives light from the west and is cladded with a prefabricated cement block with the motif of a traditional Khmer ornament, permitting indirect sunlight and natural. The eastern side is made up of low columns. Both the north and south of the structure were constructed with irregular volumes, which further explains the texture of the bricks. The main hall of the building serves the purpose of attending to the customers; aluminum and long pieces of wood were used in this part.

The west side opening was constructed with a metal lattice with the motif of the bank on the balconies' exterior, which are two meter long. The balconies contain picture windows at eye level, framing the view of the sea. The internal side is shadowy and contains a double screen (Fig. 2. 11). There is drainage in front of the building that is used to collect rain water during the monsoons (Fig. 2. 12).

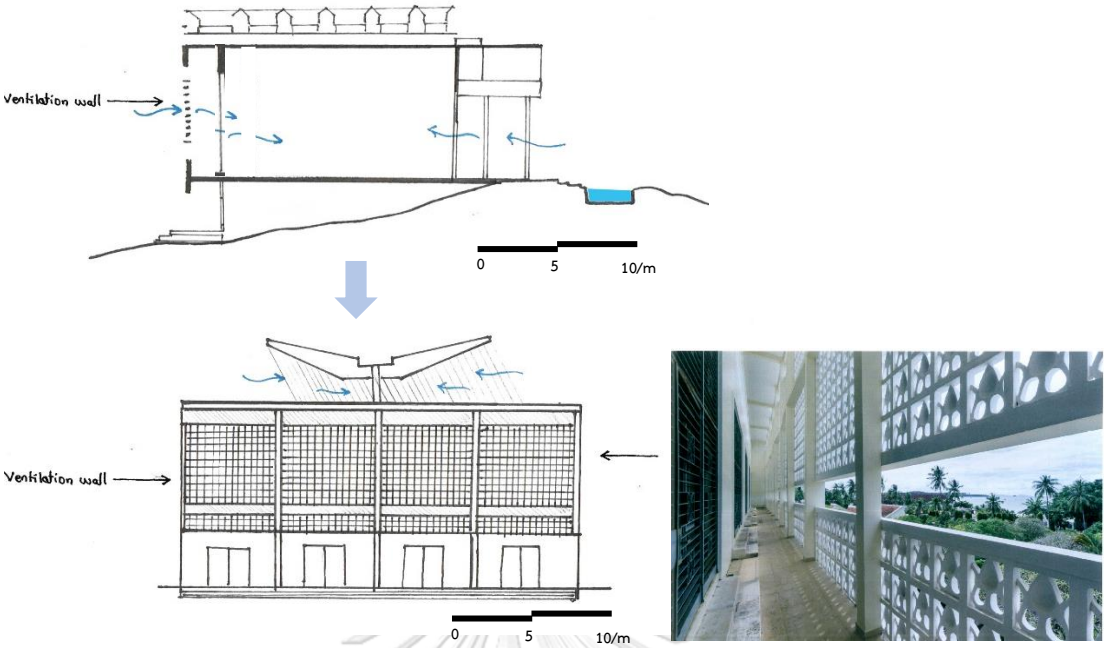


Figure 2. 11 Drawing analysis of the screen wall at the backside of the building, which allows indirect sunlight and air circulation inside the building

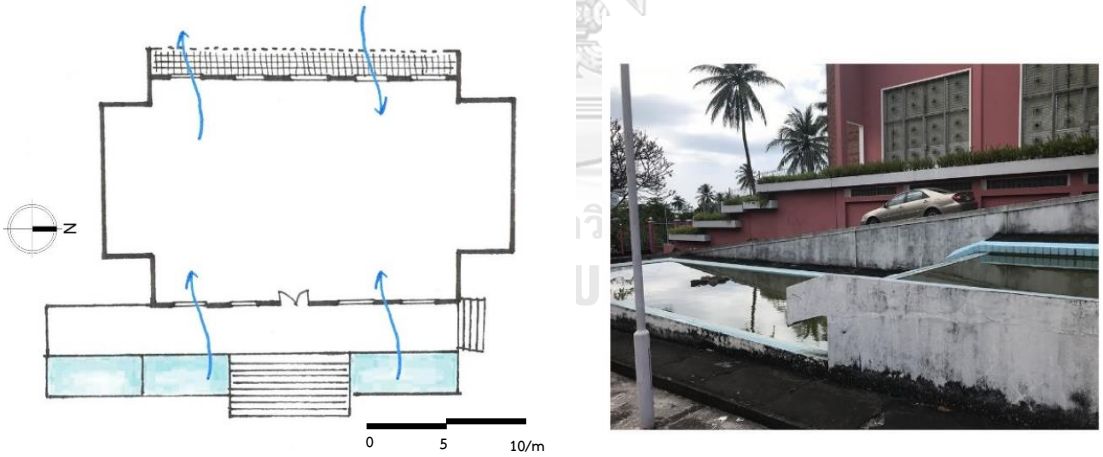


Figure 2. 12 Diagram showing the drainage in front of the building that was used to collect rain water; the water also served to cool the interiors

The most eye-catching component of the bank is the massive roof top pergola, constructed with reinforced concrete. It is raised off the actual bank roof, thus reducing the heat in the building from direct sunlight. The butterfly double roof also protects

the building from rain and provides a shaded outdoor space. The structure was also elevated off the ground to offer shade for people or vehicles (Fig. 2. 13.).

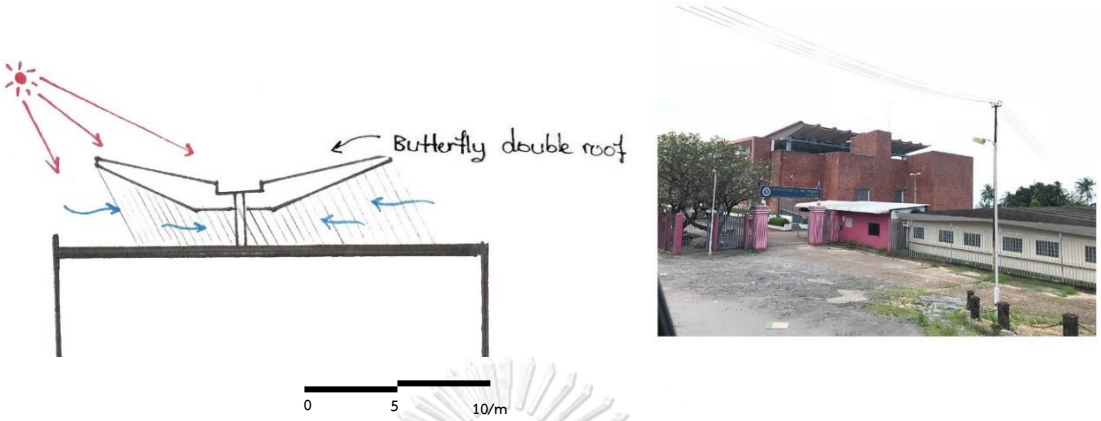


Figure 2. 13 Drawing and photo displaying the butterfly double roof (taken by the author on 05 November 2017)

The bank building is best built to capitalizing on the cooling effect of the double walls. The main reason is due to the prefabricated block that offers good ventilation into the building. There is sufficient sunlight from the outside in a natural way. The setback to the design is the not high enough walls and so the movement of air into the building will be impaired to some extent. However, this challenge is covered by the big windows present, also, the presence of perforated walls, for instance, the walls facing the seaside. The main challenge presented by the big windows is that it may allow rain into the building if not checked in time. As a result, it is possible for water to get inside the building.

The drainage used for the containment of rainwater may pose the challenge of mosquito breeding since it is stagnant and in open space. The parasites may cause the dangerous malaria disease that proves to be a health hazard. Moreover, the growth of moss and algae lead to the contamination of the stored water leading to the financial burden on the bank of purifying the water or maintenance the pool.

2.2.4 The Church in Sihanoukville

Figure 2. 14 St. Michael's Catholic church in Sihanoukville (taken by author, 05 November 2017)

St. Michael's catholic church in Sihanoukville was constructed in 1960, and it is one of the two churches that survived the Khmer Rouge in Cambodia (Ross & Collins, 2006) (Fig. 2.14). The church of Sihanoukville contains a single room, thus forming a wider free space. It does not have pews, yet with a soaring roof, an open ceiling, and towering sails, fashioned with brick latticework at both ends and sides of the building, mild breezes can enter the premises, while the internal space receives soft lighting (Fig. 2. 15, 2. 16). Dating back to ancient times, the breeze blocks were located at the center of the structure in the 1950's and 1960's. Used in both residential and commercial buildings, they are associated with vacations and a sense of being on the beach. This explains their use to characterize the maritime theme of the port town church. Furthermore, the material used facilitates the adjustment of the building's temperature on hot days by storing the heat and cooling the air. During summers, the bricks offer a cooling effect, creating a suitable and comfortable environment for the more than 50 families that assemble in the church. Another architectural benefit of the breeze blocks is their aesthetic value. The ship's sail brick lattice work at the front and sides creates a boat-shaped structure for the entire building. Consequently, a sense of culture is exuded by the way in which it stands from the ground. Overall,

every aspect of the wall augments the church's value and quality. Further, it offers an ethereal glow inside the church, which is not excessively bright or dark. Due to the abundant and continuous breeze, the insides remain surprisingly refreshing, regardless of if it is hot outside (Fig. 2. 17). Every Sunday, Sihanoukville's Catholic community visits the, coming in a vessel. The ambience is pure and relays an enchanting wholeness, as though the project and the existence of the fundamentals had said 'enough'. No additional adornment was required for this structure. The appearance conveys plain serenity, born not out of severity, but a kind of aesthetic simplicity, thus forming a perfect place to commune with God.

The design of the church by the use of prefabricated ventilation block which are perforated offers an ideal environment that allows passage of soft light and air into the church. The ability of the air to pass is felt during the hot days by the congregants as the fabricated material provides the cooling effect blocking away the heat experienced directly from the top of the roof. The room temperature is then able to be regulated during the summer time. The lighting in the room is only achieved when the sun is clear up in the sky. The room becomes dark during cloudy conditions hence the need for artificial lighting during such times.

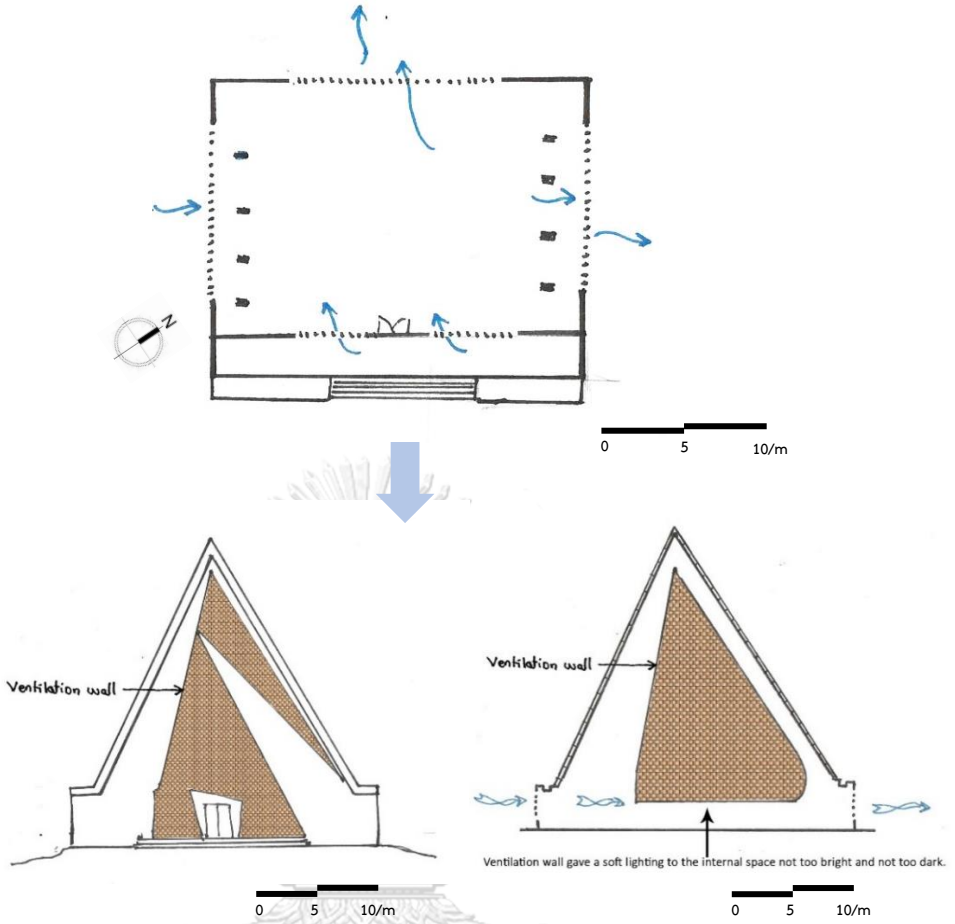


Figure 2. 15 Drawing of the layout with the front and back elevation of the building design with a prefabricated ventilation block

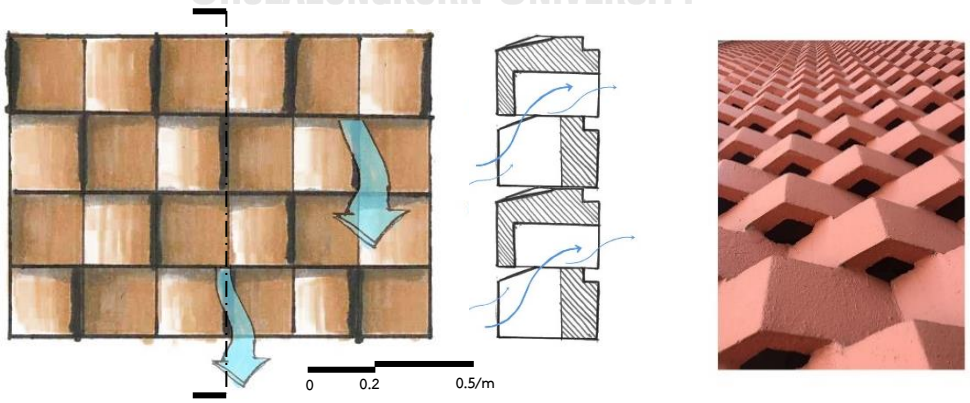


Figure 2. 16 Diagram showing a detailed view of the ventilation block, depicting the air circulation, which protects from direct sunlight and rains

Figure 2. 17 Ethereal glow lighting inside the building roof (taken by author, 05 November 2017)

2.2.5 The National Sports Complex

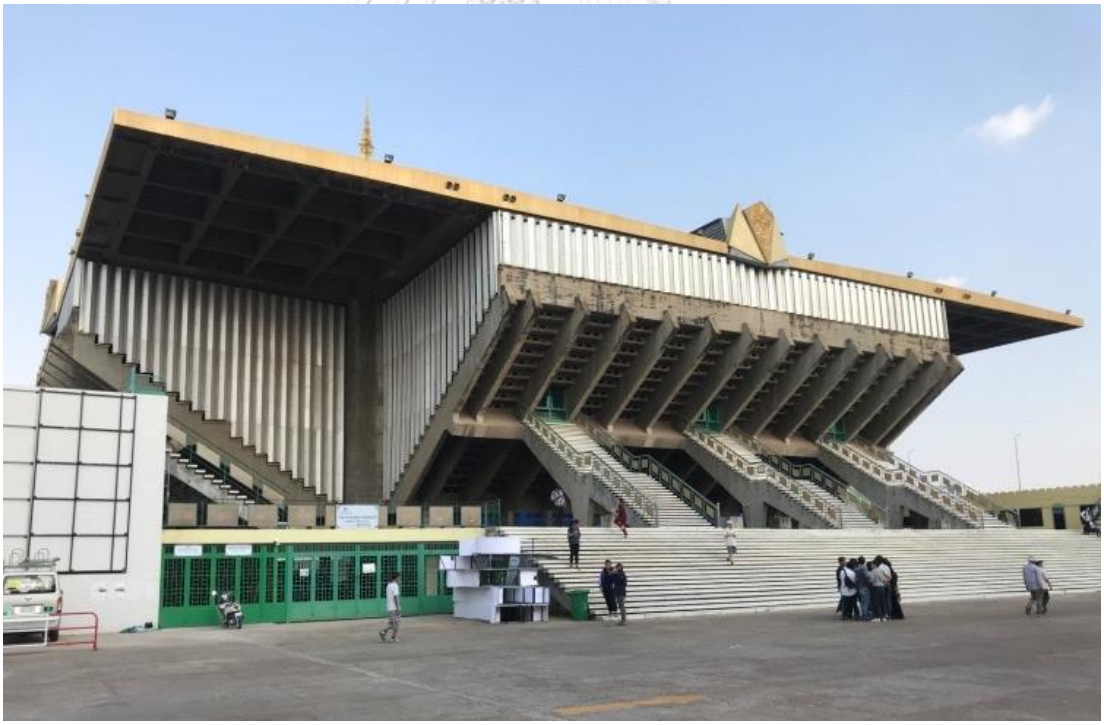


Figure 2. 18 The National Sport Complex main building (taken by author, 08 March 2018)

The most significant example of local innovations is the design of the National Sport Complex located in the heart of Phnom Penh (Fig. 2. 18). It consists three main

elements, the outdoor stadium with 50,000 seats, while indoor arena, swimming and diving arena contain 8,000 seats in total. The building was constructed in 1962 in anticipation of the Southeast Asian Game in 1963, which Cambodia was supposed to host, and also, to indicate the development and strength of Cambodia after gaining independence (Ross & Collins, 2006). Sensitive to the climatic conditions, the building prudently modulates air, water, and light. It presents a good architectural design, showing off a green or bioclimatic design. It employs precise techniques for drainage and water management: the National Sport Complex has a good drainage system. The main building houses shallow storage ponds connected to the roof, which rainwater accumulates during storms to prevent flooding and then drains it out at a gradual pace (Fig. 2. 19). The three slanted surface structures of the indoor arena functioned as a wall as well as seats for the audience (Fig. 2. 20). There are hole punches beneath the seats that allow soft light, cross ventilation for the indoor arena, and offer shade for the arena's outdoor walkway (Fig. 2. 21). The intertwining aluminum panel screen also facilitates ventilation and indirect sunlight from the outer and inner gap of the panels; without these, all corners of the arena would be without any walls (Fig. 2. 22).

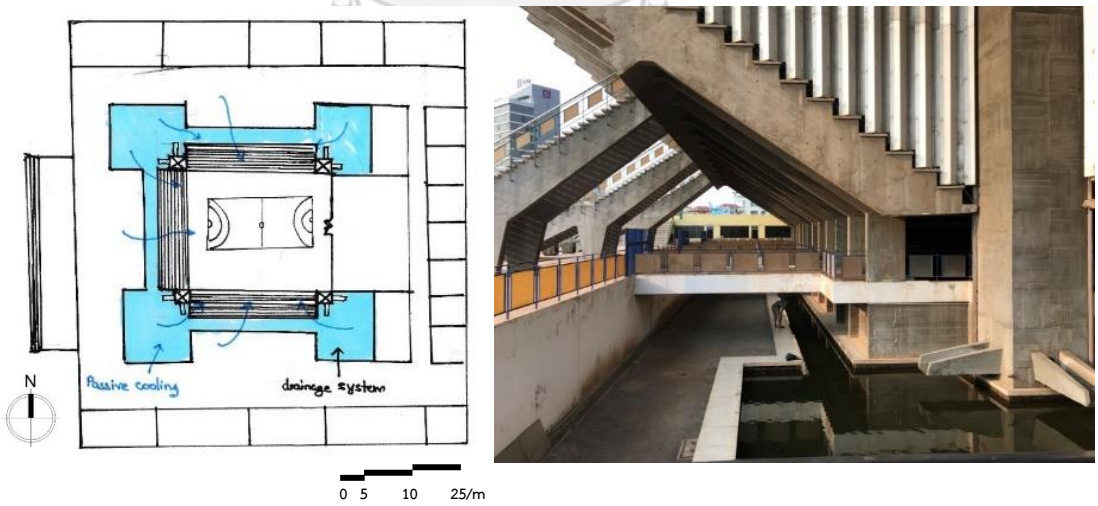


Figure 2. 19 Water drainage system around indoor the arena (taken by author, 08 March 2018)

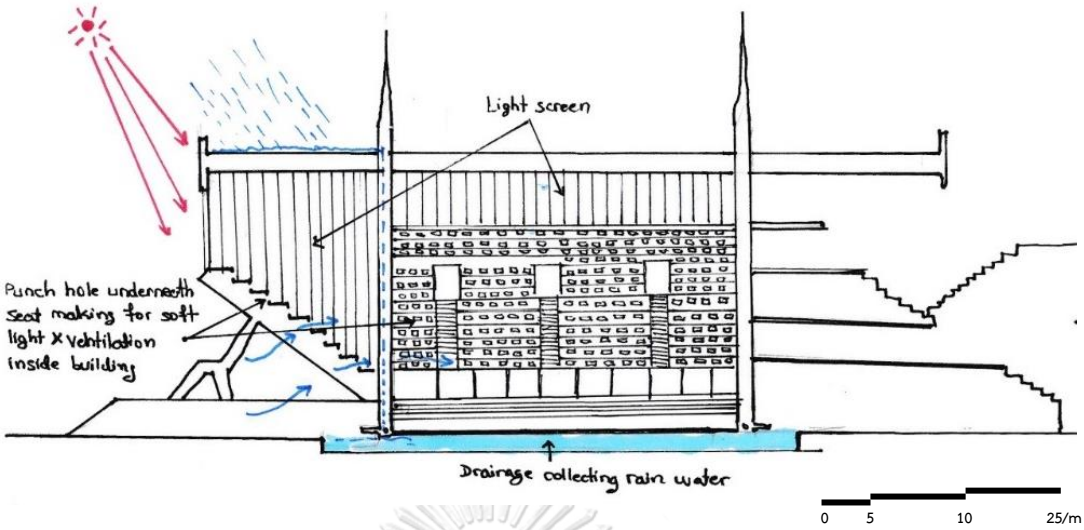


Figure 2. 20 Section drawing of a slanted wall as the wall and audience's seats

Figure 2. 21 The hole punches under of the audience's seats allow soft lighting and ventilation in the indoor arena (photo taken by the author on March 8, 2018)

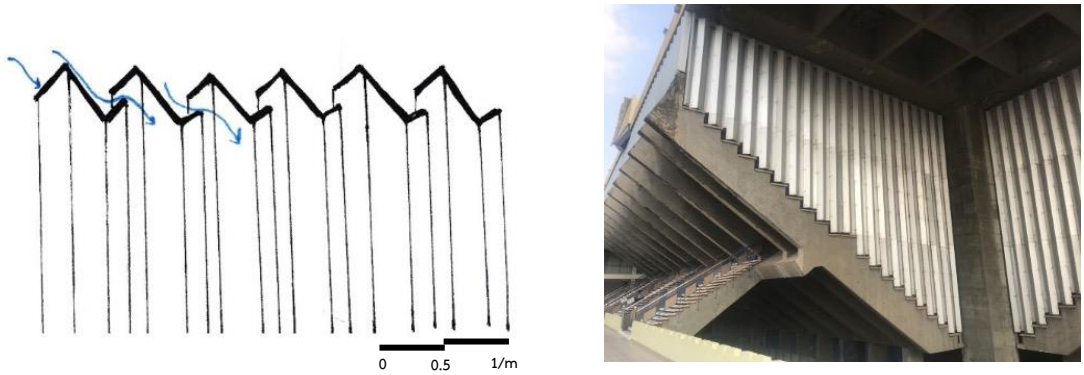


Figure 2. 22 Intertwining aluminum panels allow the soft light and ventilation (taken by author, 08 March 2018)

Even the arena's roof, Vann included his idea of allowing indirect sunlight, using the exterior part of the roof as shade for the outdoor audience. While the arena's interior is sheltered by the three quarters of the four-single detached bending square-shaped roof (Fig. 2. 23). The opening between the four main rooftop structures is covered by another opening gable roof that rises by nearly half a meter above the primary structure, allowing indirect sunlight and air circulation from the side louver, into the building, a feature known as the breathing skylight (Fig. 2. 24).

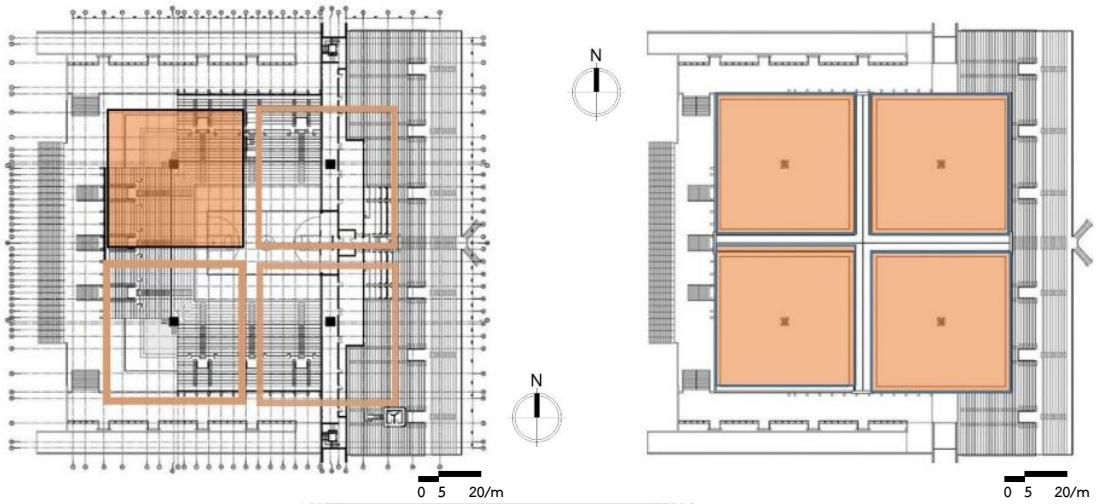


Figure 2. 23 The roof's layouts displaying an indoor arena covered by a four-square roof and outdoor audience's seats in the main building

Figure 2. 24 . The opening between the four main rooftop structures is covered by an open gable roof that allows indirect sunlight and air circulation within the indoor arena (taken by the author on March 8, 2018)

Every roof is supported by a single column at the center, resembling the shape of an open umbrella. Large scuppers on the bottom of each column nourished a moat or allowed perimeter drainage on the ground floor of the arena's outer ring walls for the collection of rainwater from the cap of the building, allowing cooling in the seating area and heat reduction inside the building (Fig. 2. 25). On the opposite side of the out stadium, on the topmost part of the east, there are three separated pendulous concrete roofs that reverberate the roofs of the interior stadium, offer cross-ventilation in main the arena and shade for the Spinning Complex created on the ridge's eastern slope (Fig. 2. 26).

Although, the sports complex drainage system is prone to the problem of blockage due to the growth of moss and algae. The growth inhibits the movement of the collected water, and it has to be frequently maintained to prevent excess water overflowing within the sports complex. The excess water could flow affecting the main building facility as it harbors the drainage water storage facility. As a result, frequent opening up of the drainage system is vital to ensure the problem of flooding at the sports complex is checked to a bare minimum. To reduce the heat inside the arena, there is the need of offering a wider space for the draining water. The draining water having a wider space will allow the enhanced cooling of the spectators seating area. However, the audience may get inconvenienced by the problem of mosquitos because the seating area is just directly below the area. This challenge has frequently affected the sports complex often.

Figure 2. 25 Scupper with a vile in the middle of the column to collect rainwater from the roof (taken by author, 08 March 2018)

Figure 2. 26 Eastern slope of the outdoor arena (taken by author, 08 March 2018)

2.2.6 Preah Suramarit National Theatre

Figure 2. 27 Preah Suramarit National Theatre in 1966. (Source: Vann Molyvann Project)

The Preah Suramarit National Theatre was also designed by Vann Molyvann in the year 1966, and it was later inaugurated as the Grand Theatre Preah Bat Norodom Suramarit. The aim of the building was to serve as a theatre and horst to the National Conservatory of the Arts. The structure's shape resembles a ship as seen on the banks of the Bassac river (Fig. 2. 27.). The idea was to have a wide stage, a facility important for Cambodian musicals and drama, allowing the spectators to a suitable dimension to observe the stage (Ross & Collins, 2006). Theatergoers needed to enter from under a triangular concrete fronton, set on stilts raised above ground level, while the staircases leading to the double-height foyer were lit and aired by the complete height claustra (Fig. 2. 28). A pool was created in the basement of the step center, to accommodate a calm space. The air from the pool facilitates extremely good air circulation in the theatre, in line with climatic condition (Fig. 2. 29). Even though there are no windows, Vann incorporated a new design, a prefabricated ventilated wall resembling fish scales (hexagonal shape), particularly designed as effective wall cladding, offering filtered light and ventilation to the building (Fig. 2. 30).

Figure 2. 28 Center staircases leading from the ground floor to the first floor (Source: Vann Molyvann Project)

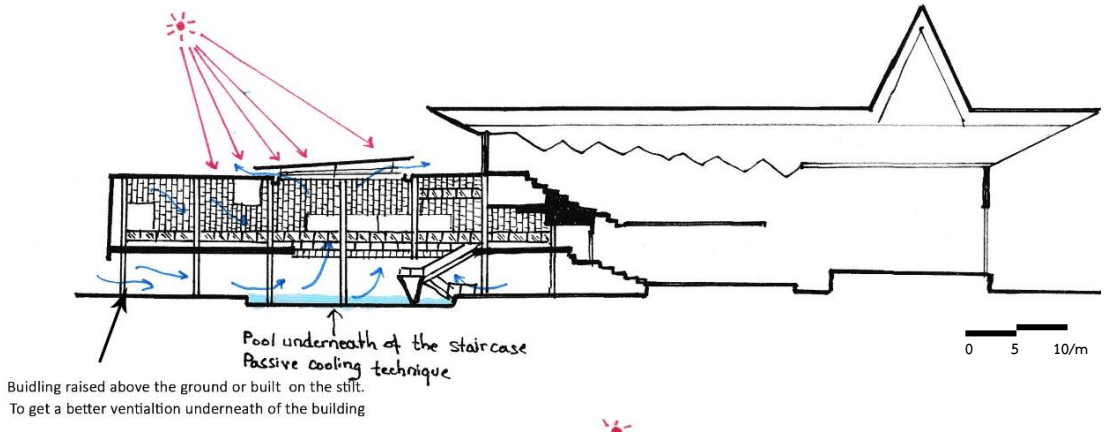


Figure 2. 29 Diagram displaying the center pool in the basement that has a cooling effect on the building's environment

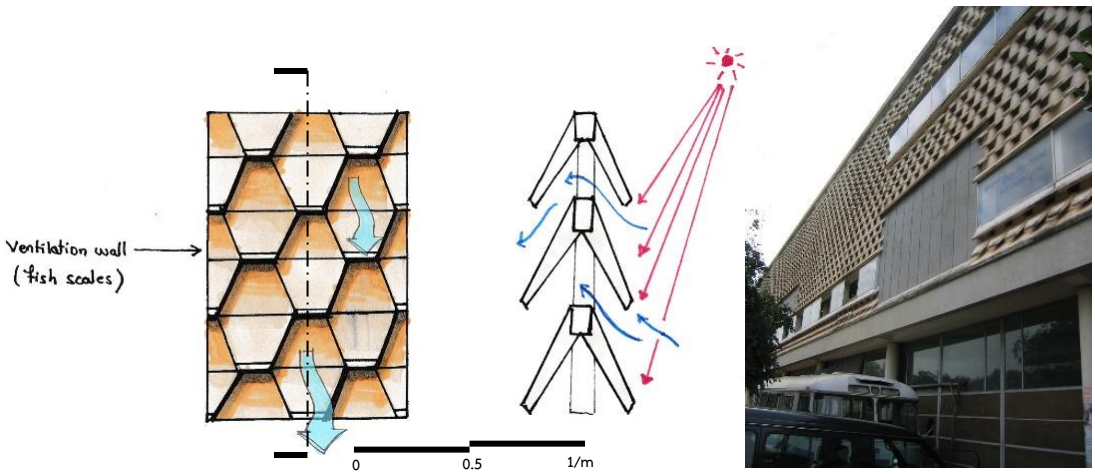


Figure 2. 30 . Diagram and image depicting the fish scales that clad the wall

Moreover, besides the auditorium's roof, which explodes into a kind of pyramid, successfully resembling a Khmer design in some way, another interesting architectural element is the triangular roof on the fronton building that functioned as a breathing skylight, combining the ventilator with the skylight, thus resolving the lighting and ventilation issue with one tool. This allowed indirect sunlight to enter from the side and the shutter let the fresh air enter and kept the foul air outside of the building (Fig. 2. 31).

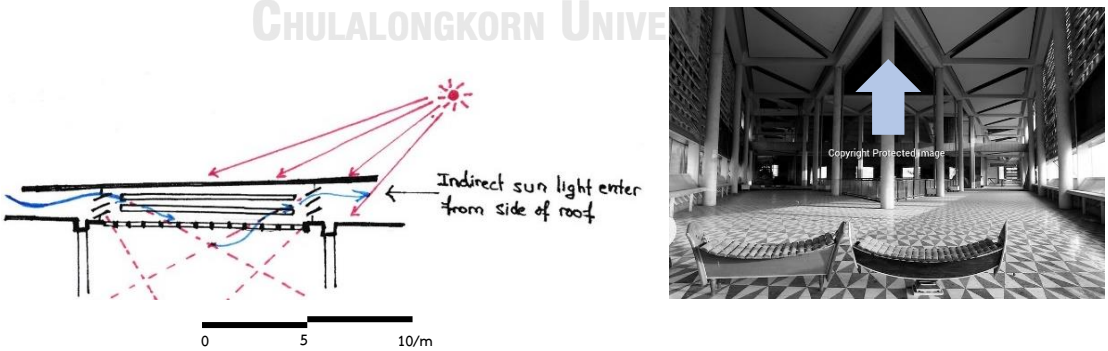


Figure 2. 31 Diagram and pictures showing the breathing skylight of the triangular roof on the front part of the building (Source: Jean Loncle, freelance photographer)

Through further analysis, no actual evidence as to how and from where the air circulation took place in the indoor auditorium seating space of the Preah Suramarit Theatre was found. However, according to those who visited the theatre before the original design was burned down, all stated the same information during the oral interviews, that is, the auditorium has no air conditioning[1]. The air in the theatre was all natural, but they were not certain as to how or where the air was coming from, since no evidence of condenser units could be seen and the theatre contains no window.

Furthermore, the perforated wall on the front of the theatre is significant to ensure sustained circulation of air in addition to the breathing skyline. However, its primary function is to ensure the challenge of lighting and ventilation is checked. The perforated walls work to ensure light can come in from the side of the structure to add to the illumination from the light coming from above. The unique hexagonal shape wall perforations and this works to make the climatic conditions favorable for the audience present. Consequently, the cool temperatures can be sustained by the space

[1] 1. Mr. Tan Juij Soung, aged 81, confirmed in an interview that there was no air conditioning system inside the theatre. He mentioned that he saw punkah made from a huge sheet of fabric that required manpower to swing; but, he was not entirely certain whether the big fabric was part of the theatre decoration or served the purpose of providing cooling for the audience.

2. Another interview with Mrs. Ung Sok Lang, aged 75 also revealed that there is no air conditioning system inside the theatre, because the majority of the ladies who went to see the performances with her brought their own hand fans.

3. The last interview was conducted with Mrs. Muy Heik, who is now aged 46. She went with her school as a student in the mid-1980's to watch the National Arts performance. She also confirmed that there was no air conditioning system in the indoor theatre, but she said that she could feel the natural ventilation inside the theatre.

below the pool which is holding cool and calm air. The air is then supplied from the containment below at the pool towards the surface where the audience occupied.

However, the pool below faces the challenge of constant maintenance due to the growth of moss and algae. The entire process of getting rid of the algae and mosses is exceptionally expensive as the problem is seen to recur especially during the summer time. Another significant challenge posed to the entire cooling by the use of the underground pool is the need for a bigger space to hold more water. The more space held, it is directly proportional to the impact felt by the entire cooling in the room. A bigger pool space will make it possible for the temperatures of the room to be able to adjust as to the desired climatic conditions to facilitate the working in the theatre.

2.2.7 Chaktomuk Conference Hall

Figure 2. 32 Chaktomuk Conference Hall (taken by author, 08 March 2018)

The Chaktomuk Conference Hall was inaugurated on November 1961. It is one of the first illustrious buildings by Vann Molyvann, originally meant for hosting public

conferences and cultural events with a capacity of 850 people. The hall was renovated in the year 2000. The suspended design gives an impression of lightness similar to the Khmer houses that floated along the canal and rivers from ancient time. The design of the building explicates several local Khmer elements by bringing them into a modern context. The conference hall has a triangular concrete structure that is suspended from a beam arranged in the shape of a fan shape around one central point (Ross & Collin 2006) (Fig. 2. 32). Vann's design idea was incorporating bioclimatic features, such as shading provided by the curved veranda and by giving the building elevation off the ground, with an open space that functioned as a multi-purpose area. Ventilation took place in both directions, starting from the ground floor building toward the back stage (west to east), and on the ground floor from the back of the building underneath the stage upward, toward the seating areas (East to West) (Fig. 2. 33). Underneath the gable roof was the double roof structure that served as an insulator to prevent the transmission of the heat from sunlight between the two layers of the roof (Fig. 2. 34). As for the seating space, there are four main entrances that allow audiences to enter or leave their seats without disturbing other members during performances. With the four entrances, there are two foyers with openable linear windows, which allow ventilation (Fig. 2. 35). The other two entrances are accessible form the veranda and enter into the seating area. They allow more air in the theatre when there are large audiences before and after the show. Moreover, another unique element of the theatre's design is the fan-shaped seating arrangement that offers audience a complete view of the stage in all directions; whether they are seated in the center, on the left or right, they can see the performance on stage without standing up or disturbing their neighbors (Fig. 2. 36).

The double roof designed in a way that only a single side of the hall was covered leaving the other part to be exposed. The roof above worked to ensure the heat from the sun does not reach the audience as it is prevented. However, the covering was only done on one part leaving the other exposed to the heat from the sun. In essence, one part of the V-shaped room on top of the auditorium was not covered which reduced the general efficiency of heat resistance as per expected. The general regulation of the temperatures as a result of the summer climatic conditions

will not be achieved as expected. The main reason is that one part of the gable roof is covered while the other is left exposed to the heat from the sun.

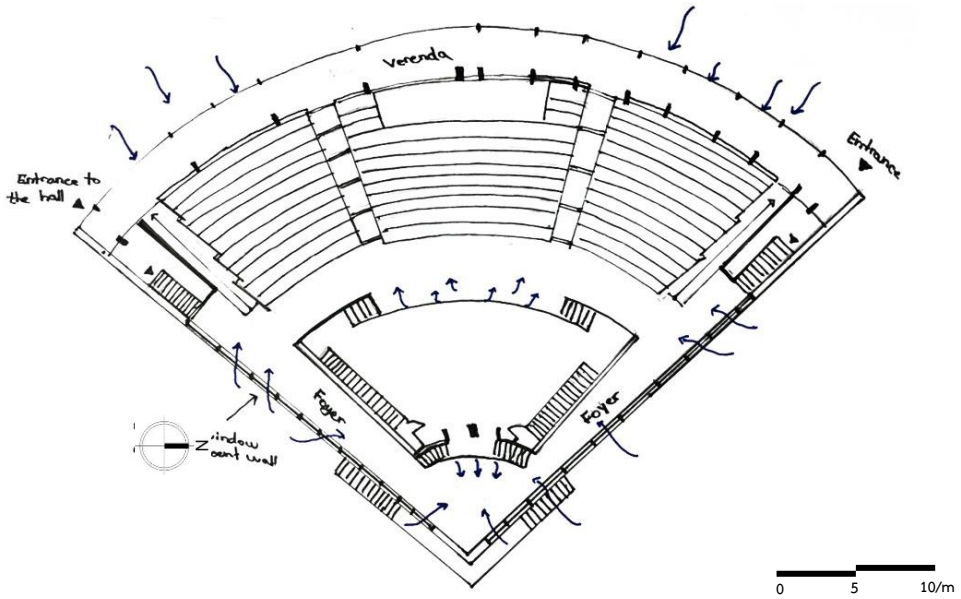


Figure 2. 33 Diagram drawing analysis floor plan of Chaktomuk Conference Hall

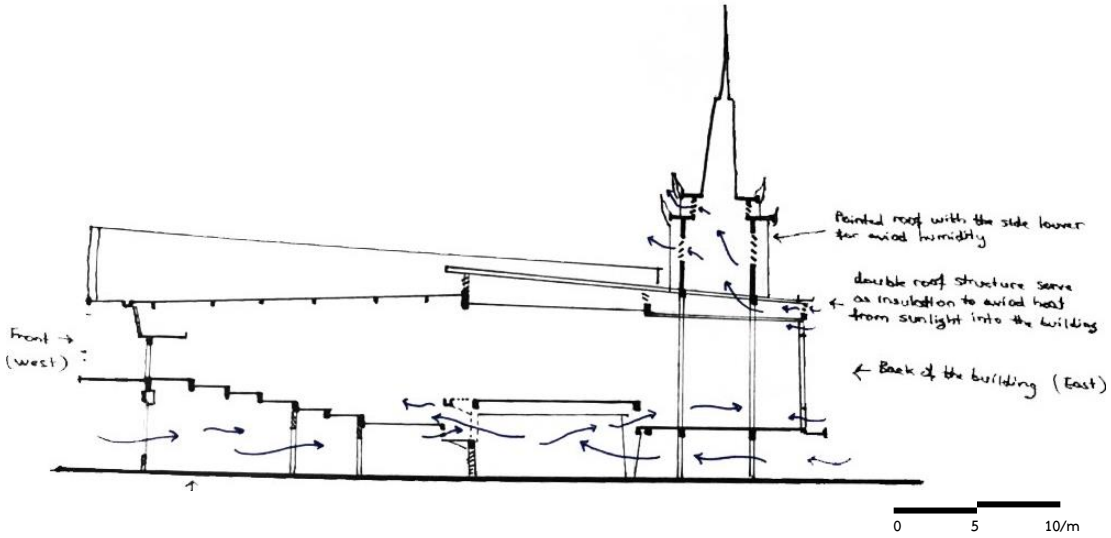


Figure 2. 34 Diagram drawing section showing air circulation inside the building

Figure 2. 35 . Photos showing the south elevation foyers with the openable linear windows that can be used for ventilation (taken by the author on March 8, 2018)

Figure 2. 36 Auditorium space and traditional performance (source: Phnom Penh Day Blog)

2.2.8 Teacher Training College

Figure 2. 37 Teacher Training College main building (taken by author, 08 March 2018)

The designing of the teacher training institute was started in 1965. The process of its redesigning slowed down its implementation, and the final design was approved in 1972. The college was meant as a foreign languages institute (Fig. 2. 37). The institute is a modern construction with elevated sideways linking the main building with the nearby structures. There is a library at the west end of the principal hall; the handrails are beautified by Naga statues (Fig. 2. 38, 2. 39). The small classrooms have a seating capacity of 35, with the sidewalls getting the natural light, thereby hindering external distractions (Fig. 2. 40, 2. 41). The western and eastern side classrooms are both linked to the middle hallway with a screen wall (perforated wall) that allows indirect light and air ventilation (Fig. 2.42). The ground floor of the building comprises offices set in the center of the circular building. The library's model was inspired from a straw hat, a Khmer straw hat, which can also be seen in the front part of the main building. For this purpose, concrete columns on the outside of the building were used to provide

shade for the building, and it was surrounded by water to allow a passive cooling design technique (Ross & Collins, 2006) (Fig. 2.43).

The training college is designed to stand the test of the extreme temperatures, especially during the climatic conditions during summer. The strategy of designing a pool to surround the massive structure is exceptional to facilitate the total cooling effect. However, there exist challenges presented by the use of this initiative that includes the growth of moss and algae in the water leading to the contamination of the pool. Moreover, there exists health hazard posed to the people in the environment since the pool water is not fenced by rails to offer protection in case of an accident. This problem is significantly posed to the children as compared to the adults as they are considered to be helpless in case they fall into the pool. Necessary amends need to be taken to ensure railing protection are put in place to avert any future accidents.

The pool surrounding the training college building is large enough to offer the much needed total cooling effect to the massive training college structure. However, since the pool surrounds the entire college, this translates into the loss of vital space that may be used in the development of the college by coming up with other useful facilities to improve the learning processes.

The double wall structure of the college building poses the challenge of cleaning due to the tight spaces that are usually inaccessible. The spaces in between the walls are usually characterized by the pillage of dust and dirt. Moreover, birds usually like to build their nests in these spaces leading to the compromised air circulation into the building. The result is that the building aeration will be a bit compromised hence not achieving total cooling inside.

The third-floor wall of the training college, however, is effectively designed to protect the interior space from the action of direct sunlight. The general effect is the presence of a good shade offering a conducive environment for the harsh external climatic conditions experienced outside. However, due to dust obstruction of the space between the double walls, space may not be fully utilized in the cooling mechanism of the room.

The perforated walls work to ensure there is optimum penetration of indirect lighting and that ventilation of the building is at its best in any given time. However,

there is the challenge of poor visibility from inside towards the outside direction. Consequently, the poor visibility is felt from the outside towards the inside of the building.

Figure 2. 38 The library and classroom at the west of the principal hall, with naga statues beautifying the handrails and elevated side walk connecting it to the classroom (source: A+U Magazine)

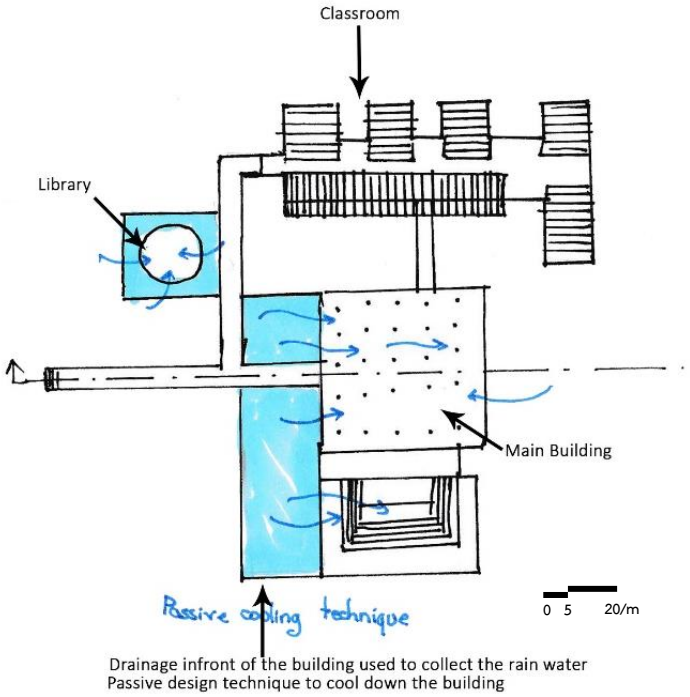


Figure 2. 39 Drawing analysis layout of Teacher Training College showing the adjacent drainage and passive cooling design technique

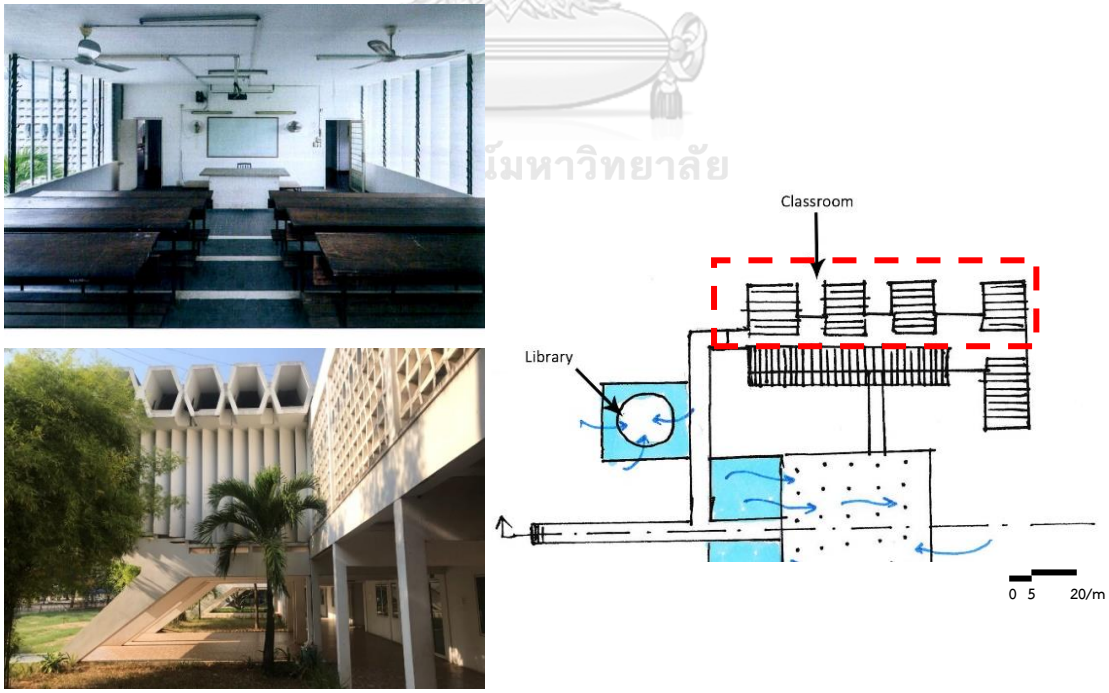


Figure 2. 40 The west side classrooms with sidewalls illuminating the natural light, thus preventing external distractions

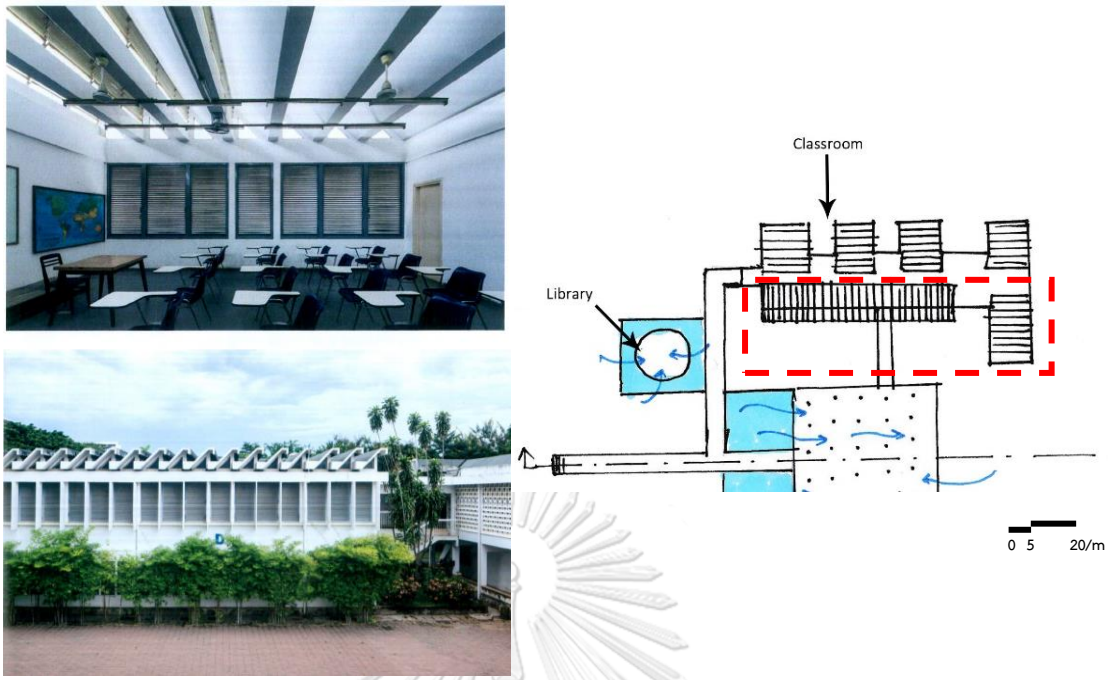


Figure 2. 41 East side classrooms with the sidewalls illuminated with natural light, hindering external distractions

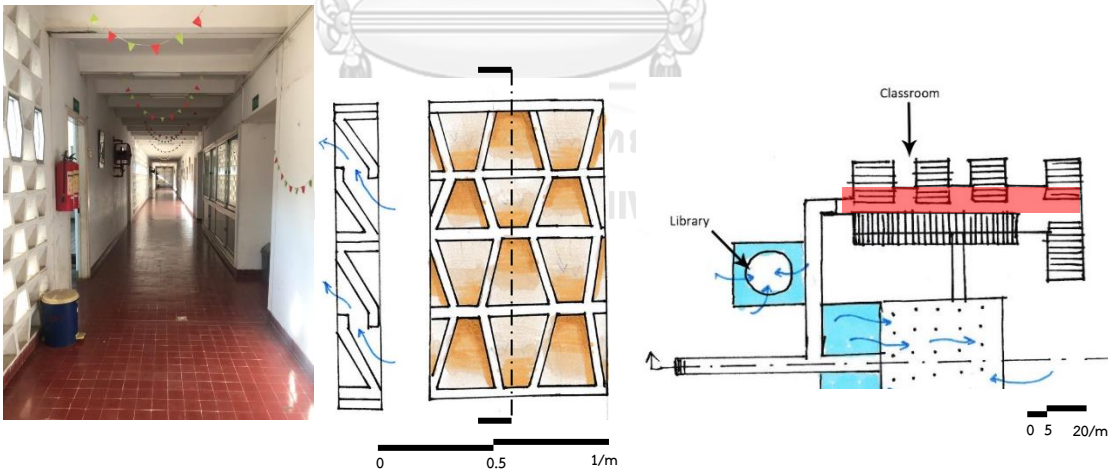
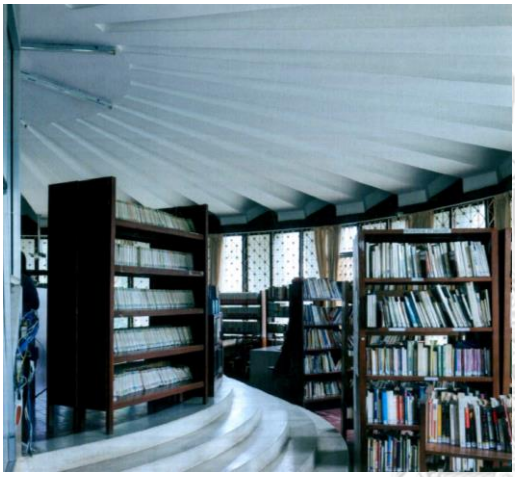


Figure 2. 42 The hallway of the classroom with the screen wall (perforated wall) that allows indirect light and air ventilation (taken by the author on March 8, 2018)



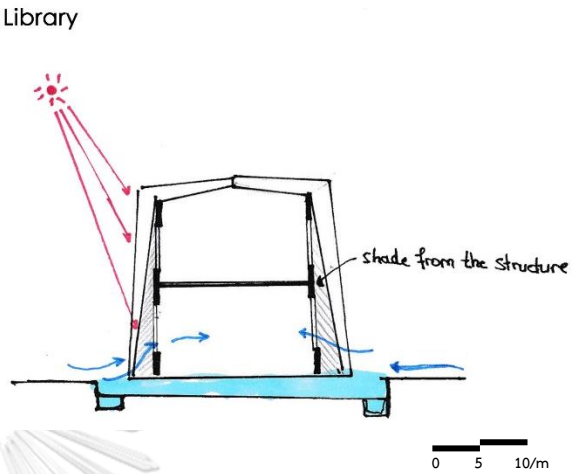


Figure 2. 43 . The library design reveals the structure to the building's outside; it used for shading the building and is surrounded by a water body to allow a passive cooling design

The Foundation of the Building

The underground of the main building, which is identical to an inverted pyramid, has a car parking, with each floor overhanging the lower ones, creating a geometrical impression while also reinforcing lighting and shading the facades (Ross & Collins, 2006). The reallocating of the underground of the building as a car parking was extracted from a Cambodian trajectory. The open space beneath the class labs is utilized for parking bicycles. The ground floor was modernized by Vann. Traditionally, the space under Khmer houses was used to shelter livestock (Fig. 2. 44).

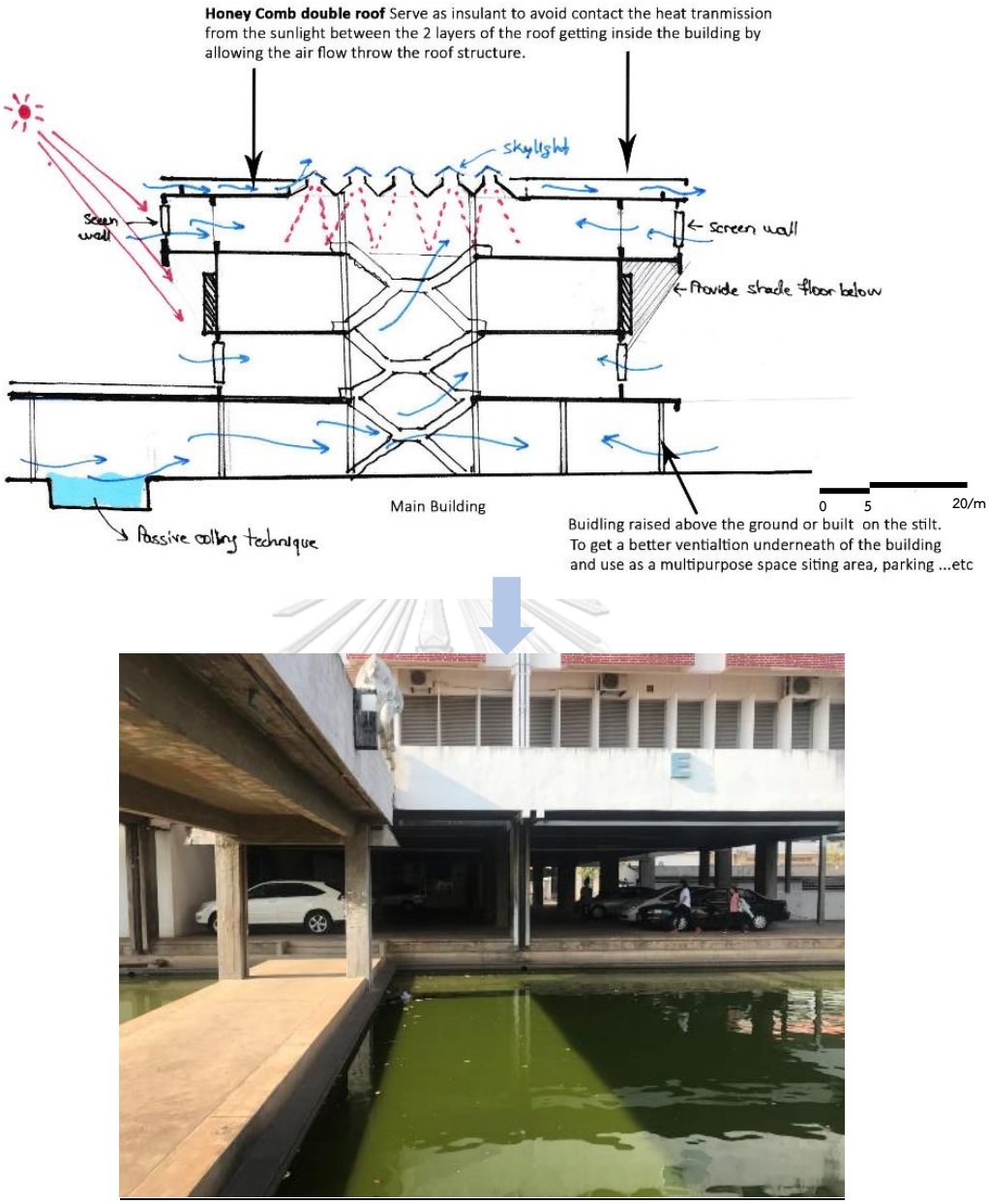


Figure 2. 44 Diagram drawing analysis of the main building's design, raised on a stilt for better ventilation and to create a multipurpose space underneath the building (taken by the author on March 8, 2018)

Adjustments to Tropical Climate

The new Khmer building illustrates just how simple it is to make users comfortable in a tropical climate. The central façade is located in relation to the north. It opens onto a courtyard, with the forest trees providing a cool breeze (Fig. 2. 45)

(Ross & Collins, 2006). The southern façade consists of concrete panels that are opened to shield the corridor from direct sunlight. The corridor itself acts as a buffer to the room's walls. Giving the building elevation allows aeration of the lower part and makes for a perfect meeting place. The raised underground protects the building from damage during floods. The high ceiling is conducive to natural cooling, which helps against the high humidity.

Figure 2. 45 The view from the north toward the central façade with an opening on a courtyard with the forest trees providing cool air

The Walls of the Building

Inside the main building, there is a massive wall connected to the balconies, staircases, and columns, a design that allows light to enter from the facades (Ross & Collins, 2006). The structure comprises fantastic teaching labs comprising separate structures instituted on lowering columns, which represents another experiment with the elements of roofs. The connecting passageways are formed by the adjacent perforated wall (Fig. 2. 46). The light gets filtered from the windows, while also allowing a good view of the outside. Vann's work employs tools he developed over the years

in response to the climate and molded his style accordingly. The architect fashioned the interior space like an opening window to allow aeration, with double walls acting as a shield from direct sunlight (Fig. 2. 47). The red bricks were used in the outward walls, allowing the air gap to separate it from the inner wall.

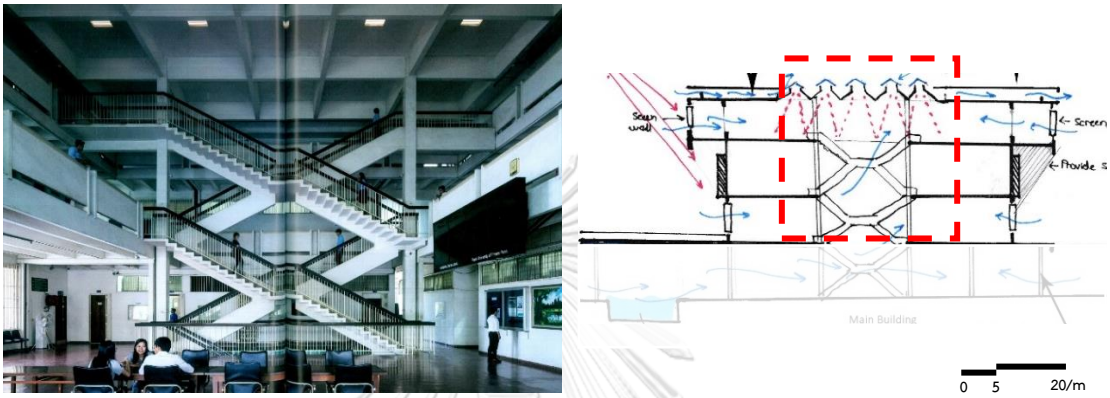


Figure 2. 46 The First floor of the main building hall (source: A+U Magazine)

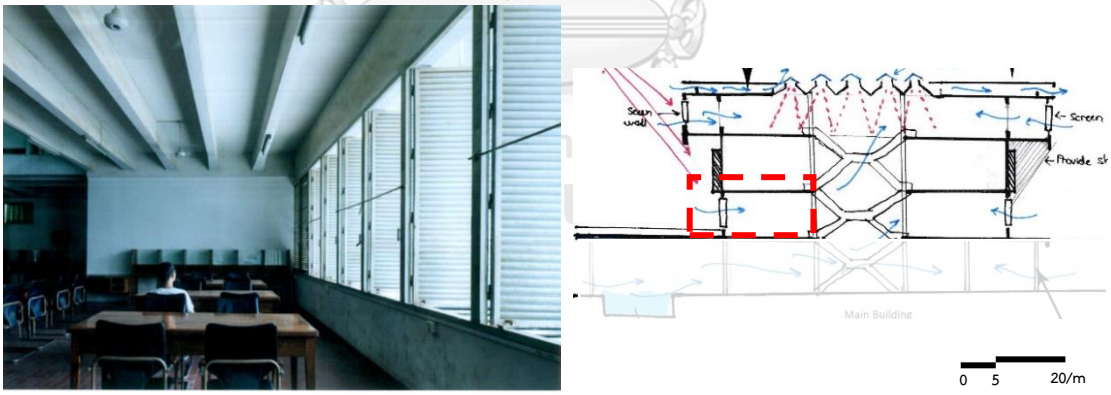


Figure 2. 47 Light is filtered by the windows, with a good view of the outside (Source: A+U Magazine)

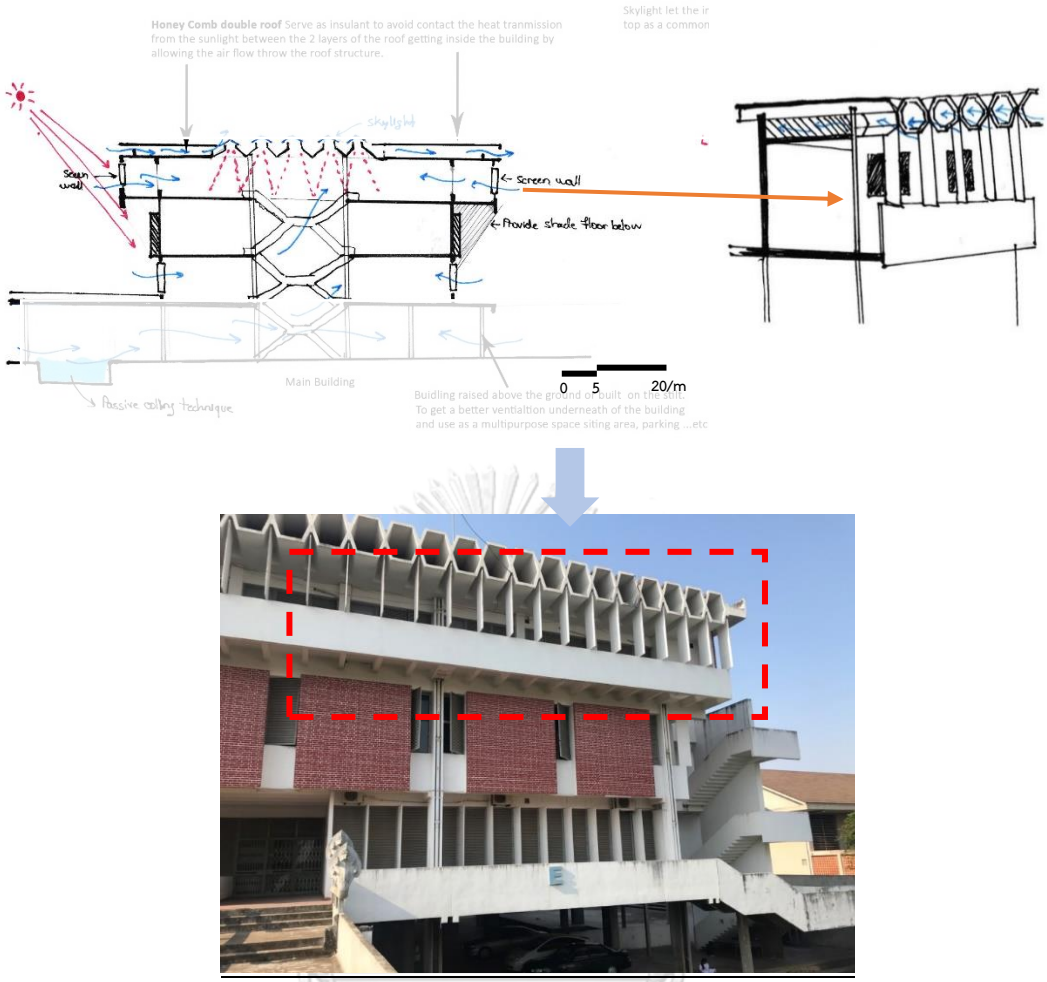


Figure 2. 48 . Interior space with opening windows to allow aeration, with double walls serving as a shield against direct sunlight

The Roof of the Building

The roof is spacious to give shade to the walls; it allows a large volume of air that shield the building top from sunlight (Ross & Collins, 2006). The double roof helps evade transmission between the two layers of the roof (Fig. 2. 48). This provides a perfect meeting place for people. The designer included double roofs to allow a natural aeration system between the walls and roofs. The honey-combed strengthened roof facilitates ventilation in the interior space, with the skylight allowing only light from the sides, barring it from the top (Fig. 2. 49, 2. 50).

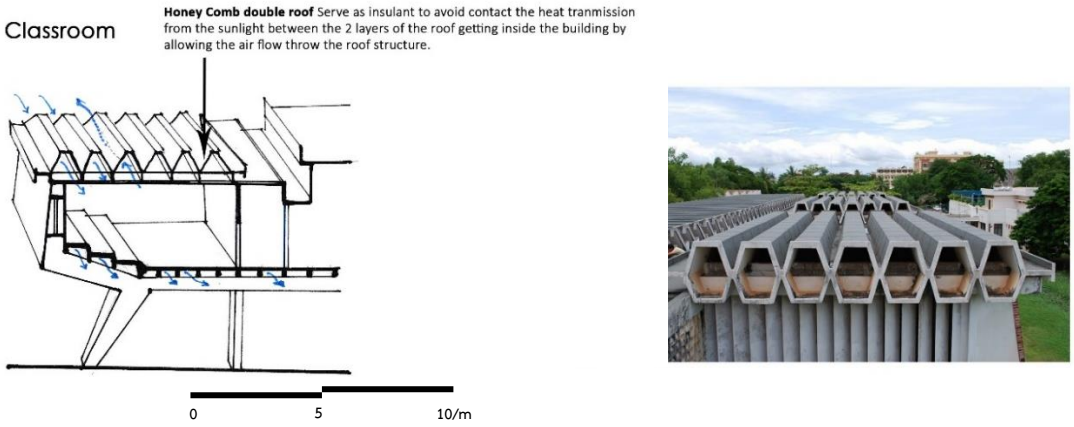


Figure 2. 49 Honeycomb double roof provides insulation against heat from sunlight by allowing it to flow through the two-layered structure

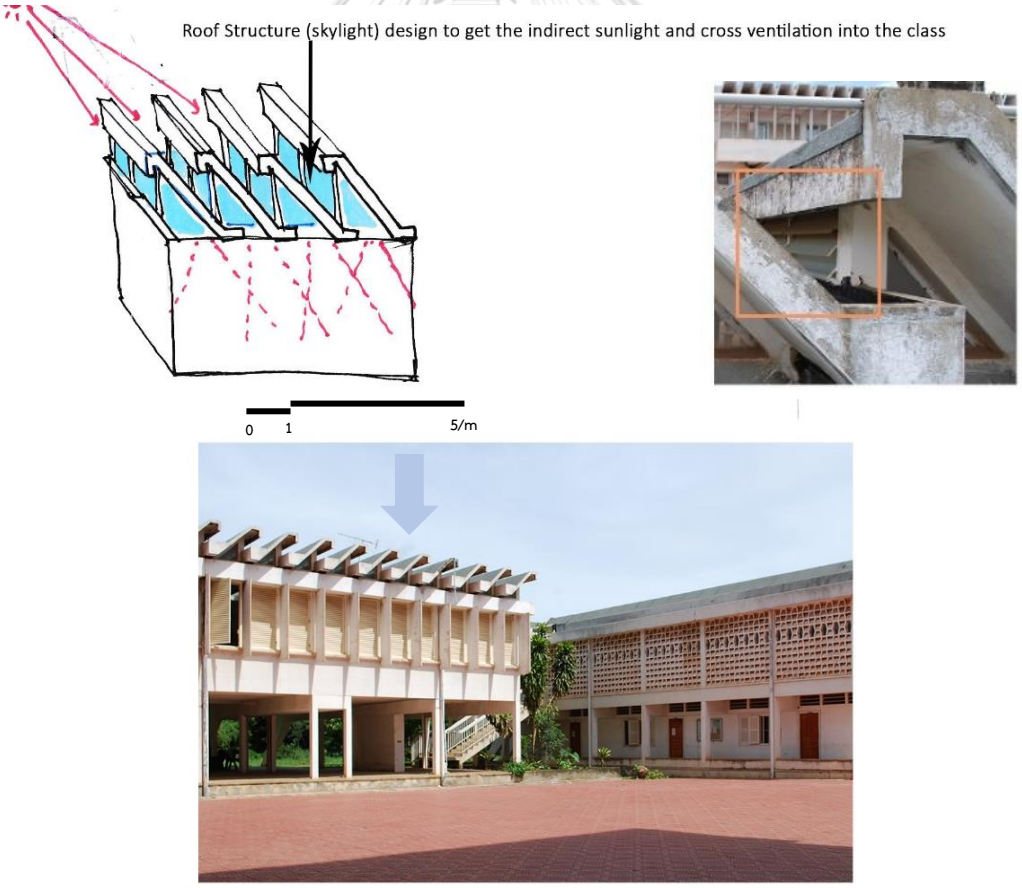


Figure 2. 50 Diagram analysis showing the skylight design to gain indirect sunlight and allow cross ventilation in the classroom

2.2.9 The State Reception Hall

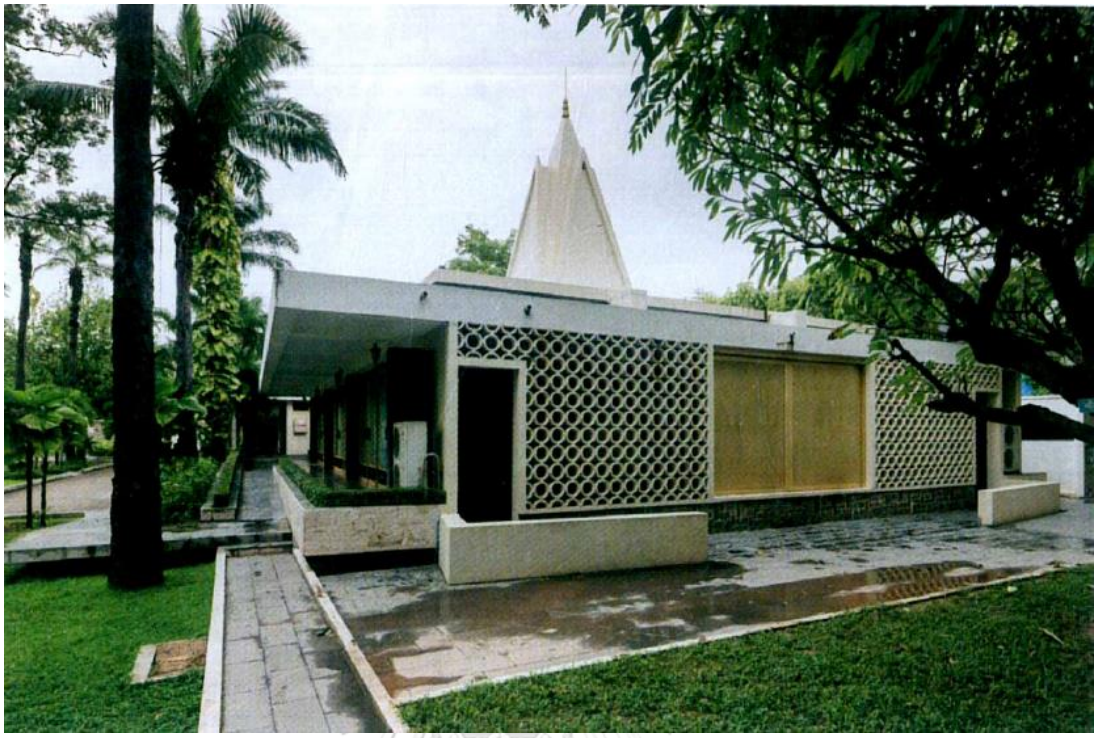


Figure 2. 51 The State reception Hall 1960s (source: A+U Magazine)

The State Reception hall is one of the largest structures in an area with extensively complex buildings, which was formerly known as the Chamkarmon State Palace (Fig. 2. 51). In the year 1966, the Chamkarmon State Palace was inaugurated by President Charles de Gaulle of France. Most of the buildings in the Chamkarmon State Palace are renowned due to their unique roofline that contain repetitions of numerous triangular concrete peaks (Penny, 2008). The peaks are unique because they link all the buildings together and also allow ventilation. The climate is rather humid and the architect must have focused on this fact when he placed the high peaks. The State Reception hall touches the ground with a circular concrete wall, a courtyard at its center, with a rectangular pool serving as drainage for collecting rainwater, again using the passive design technique for providing cooling in the building (Fig. 2. 52). The concrete wall and circular ground allow gentle and dappled light and ventilation (Fig. 2. 53). The main reception area, designed with peaked tower, recalls the elongated vertical pitch present in religious structures. It is built in a simplified undecorated

concrete form, also allowing indirect sunlight to enter from the four faces and further air circulation into the building (Fig. 2. 54). Moreover, the repeated triangular concrete peaks, referred to as V-shaped double roofs of the main entrance hall and corridor connected to the main reception building help evade transmission between the roof's two layers, by allowing air flow through the structure (Fig. 2. 55). The external walls are double-walled, containing natural stones with decorated and polished concrete columns.

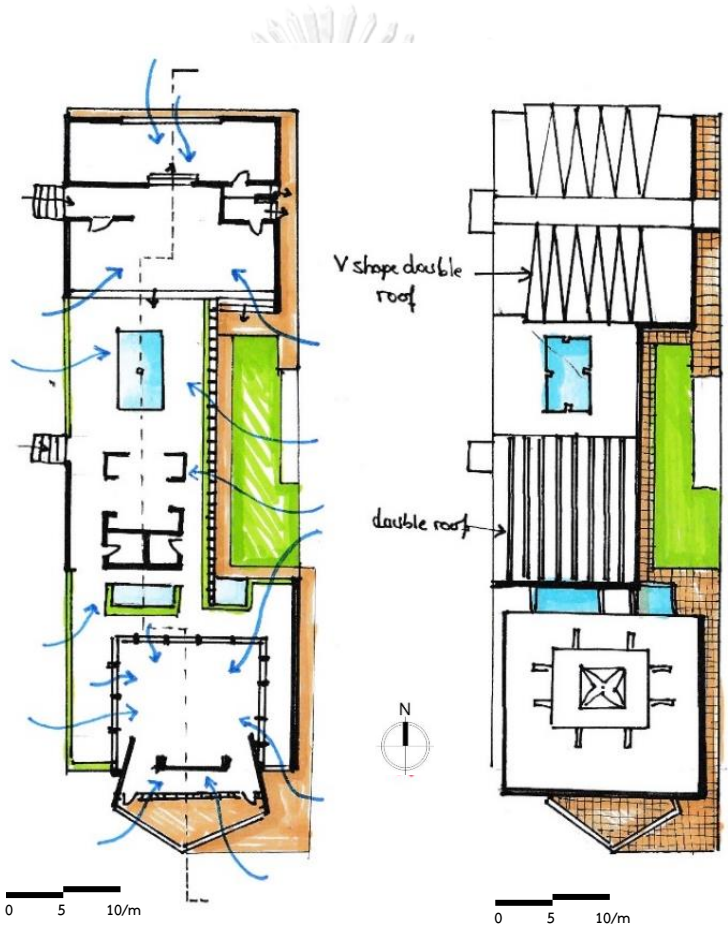


Figure 2. 52 Diagram drawing analysis of the building's layout, designed with a central courtyard, a rectangular pool serving as drainage for collecting rainwater, using a passive design technique for cooling the building

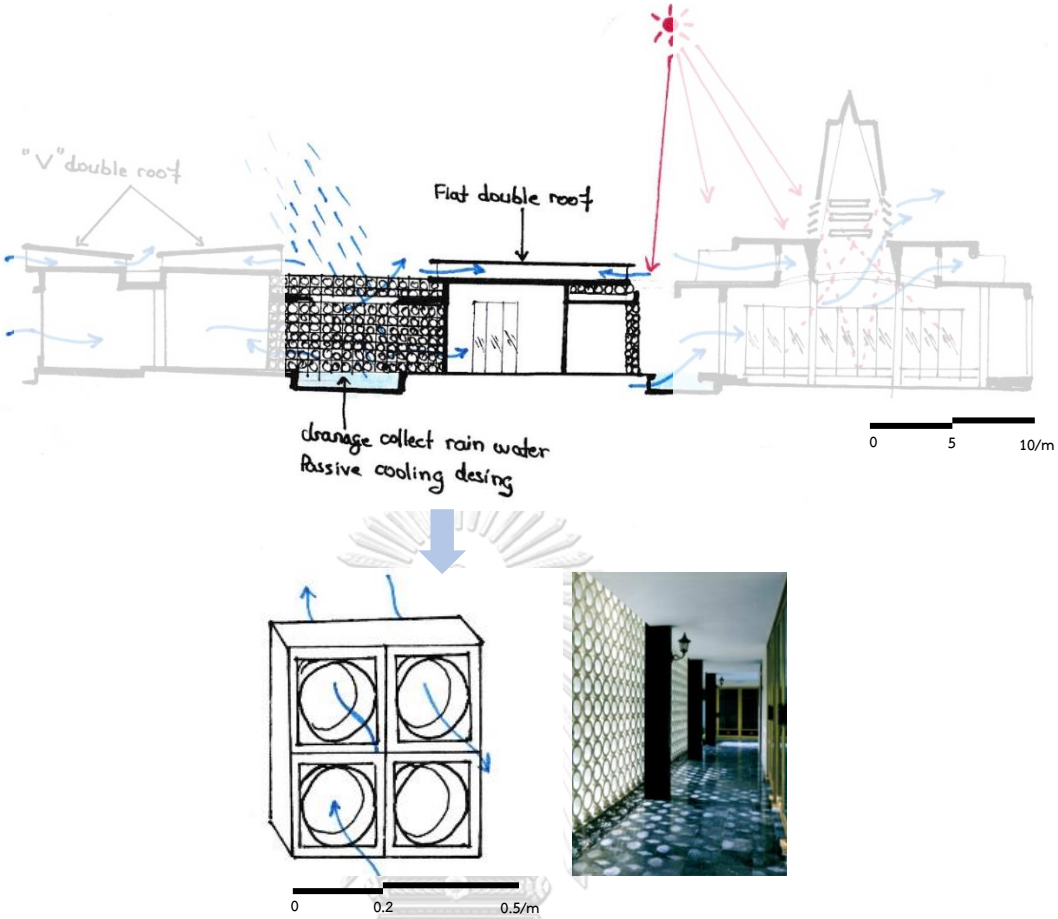


Figure 2. 53 . Diagram drawing section showing the concrete wall and circular ground design that allow gentle and dappled light and ventilation

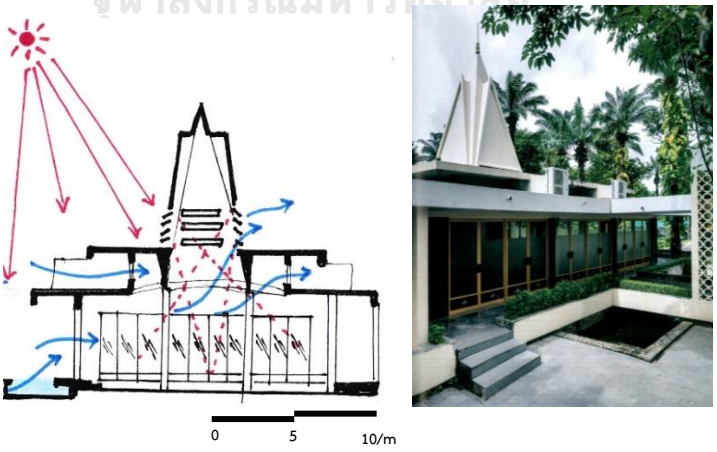


Figure 2. 54 Diagram drawing section revealing the peaked towers that allow indirect sunlight to enter from the four faces and further air circulation into the building (Source: A+U Magazine)

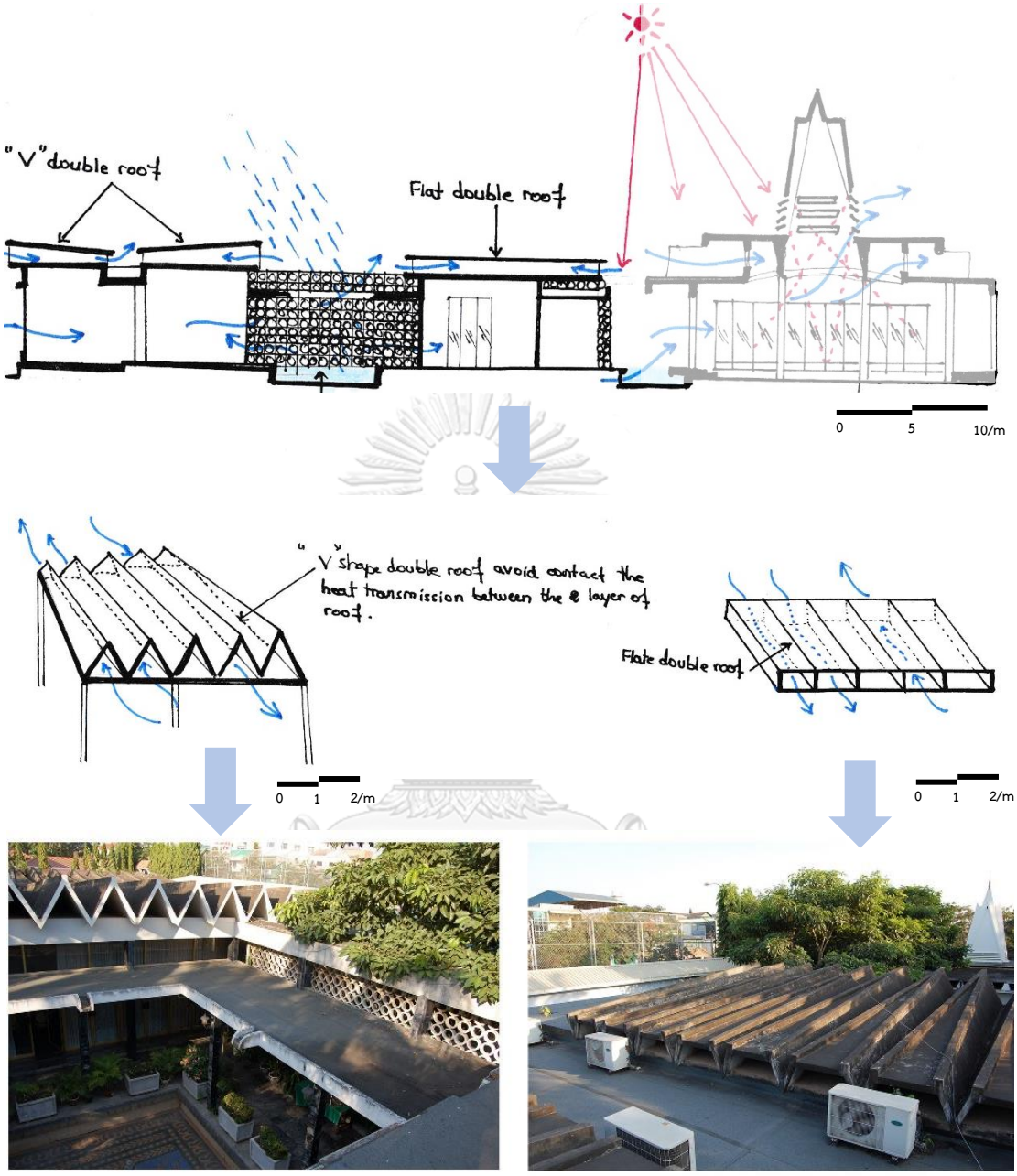


Figure 2. 55 The diagram section showing the repeated triangular concrete peaks, referred to as V-shaped double roof, in the main entrance hall and the corridor connected to the main reception building

2.2.10 Sangkum Reastr Niyum Exhibition Hall

Figure 2. 56 Sangkum Reastr Niyum Exhibition Hall (taken by author, 08 March 2018)

The exhibition hall was inaugurated in 1961 and its construction was completed between the years 1962 and 1967. The hall is situated in Phnom Penh. It was projected as a cultural complex, primarily intended to present the industrial, agricultural, and national planning achievements of the Prince Sihanouk's Sangkum Reastr Niyum movement (Ross & Collin 2006) (Fig. 2. 56). The building comprises wing walls and deep eaves to offer shade from the direct sunlight (Fig. 2. 57). The building's roof was painted in white concrete that rises to the shallow peaks and is sustained by the square-molded white concrete columns. It was sheathed in the non-painted red bricks, with the windows running in the constricted horizontal band beneath the ceiling and in vertical strips at the corners of the building (Fig. 2. 58). This was done to allow light to enter the galleries and, at the same time, preserving maximal solid wall space for the exhibition.

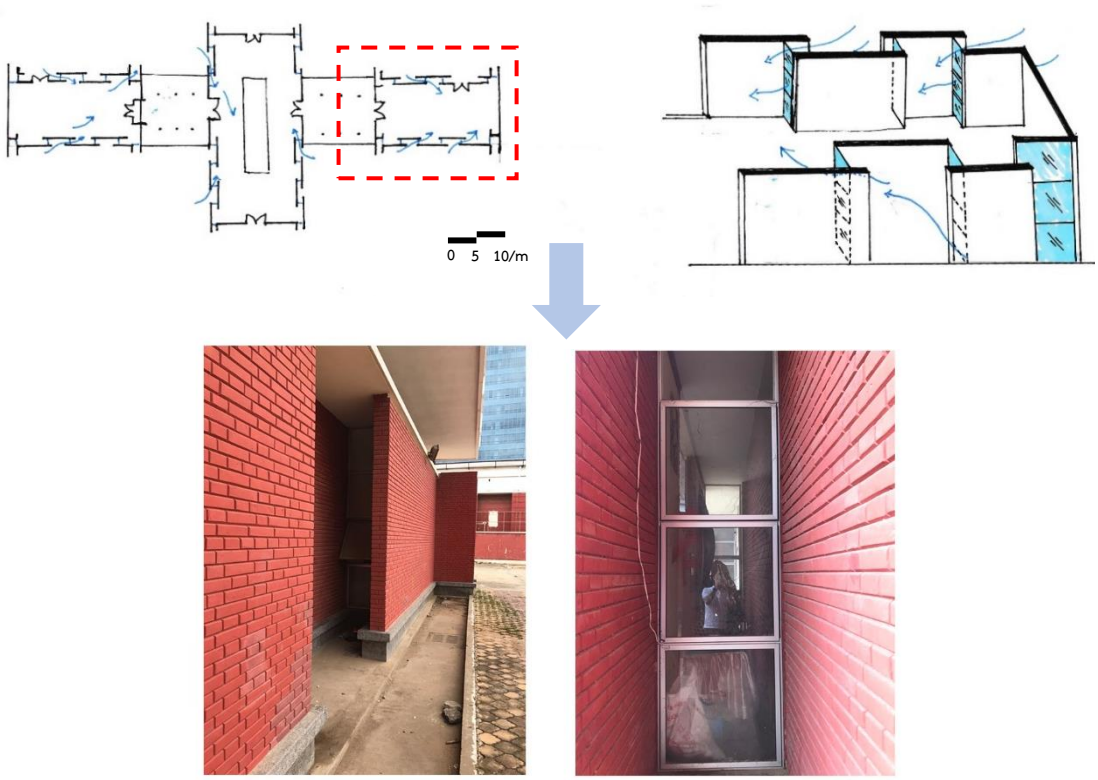


Figure 2. 57 Diagram drawing analysis and photos displaying the wing walls and deep eaves structure, which offer shade from direct sunlight and allow ventilation in the building

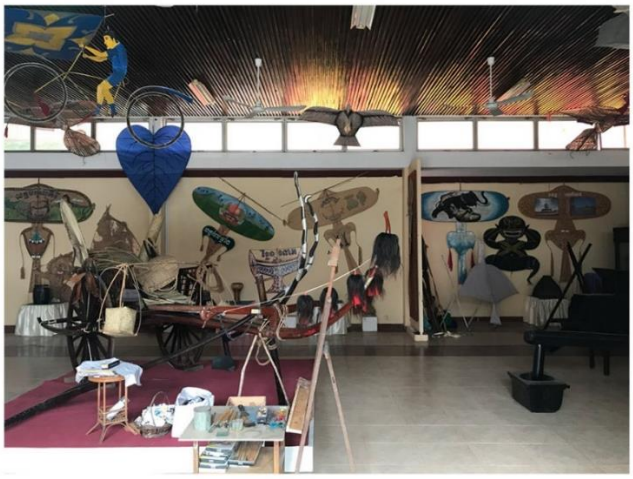


Figure 2. 58 Windows running in the constricted horizontal band beneath the ceiling, arranged in vertical strips to allow light to enter galleries

2.2.11 The House for Norodom Sirivuth's Mother

Figure 2. 59 The House for Norodom Sirivuth's Mother (source: Vann Molyvann project)

The House for Norodom Sirivuth's mother was located in Phnom Penh, Cambodia. Norodom Sirivuth belonged to a Cambodian royal family and was intended to function as a palace or resting place. The House for Norodom Sirivuth's presents a perfect rectangle on all sides with a flat roof (Project, 2017) (Fig. 2.59). This house plan is extremely similar to the bungalow typology, for instance, its aims to offer convenience of living in a fairly small and humble structure that creates a homely environment. The upper level cantilevers over the lower flow provide shade to the curtain walls beneath. They block the sun. In order to make them more suitable for a tropical climate, the balcony was added around the structure, starting from the upper segment. The balcony bears vertical shade panels that can be adjusted to regulate the amount of air and light entering the house. Consequently, it is easy to control the climate of the room at any time of the day, not to mention the small garden, full of trees, on all sides of the house. The main entrance is characterized by an elegant concrete arch that creates a serene environment in the compound. Moreover, the

building touches the ground directly with a very slight elevation. The architect wanted to allow ventilation and shade at the same time, and this was rather difficult with the tropical climate. There is a concrete spiral staircase at the center of the building that leads to an opening in the upper level. The opening facilitates air circulation and light (Fig. 2. 60, 2. 61, 2. 62, 2. 63).

Figure 2. 60 Drawing analysis of air circulation on the ground floor, the cantilevers of the upper floor, which provide shade to the glass curtain below

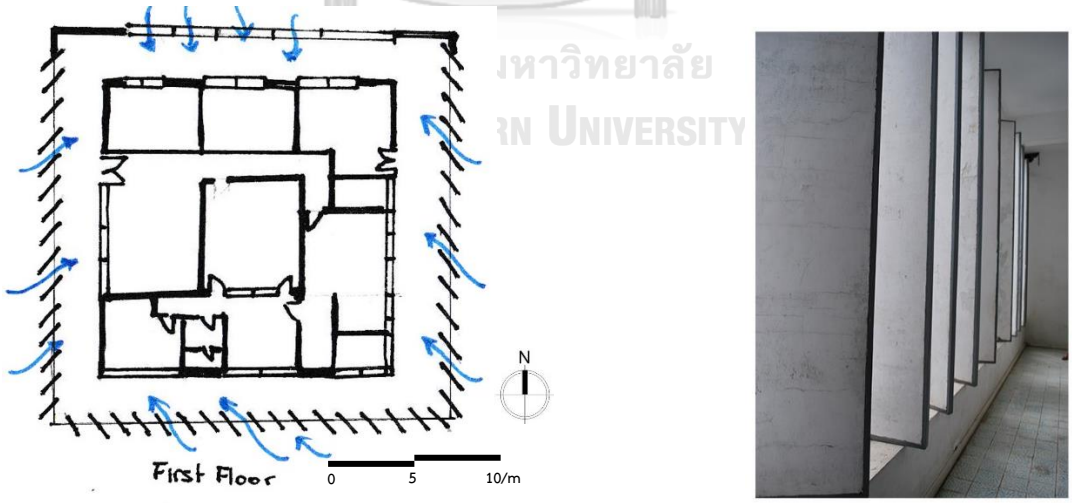


Figure 2. 61 Diagram analysis of the first floor plan, designed with a balcony on all sides and vertical shade panels, while the panels can be tilted to allow air and light to enter the space (double wall)

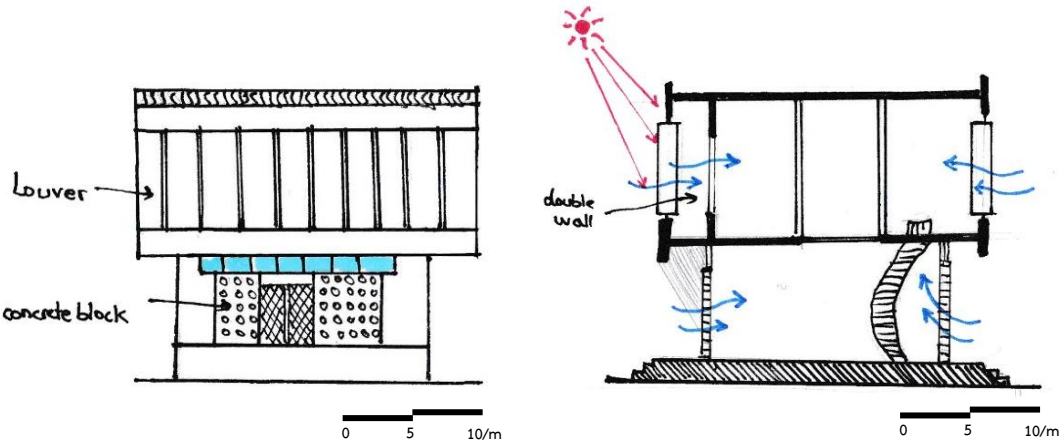


Figure 2. 62 Diagram drawing showing the section, air circulation and double wall that allow indirect lighting into the building

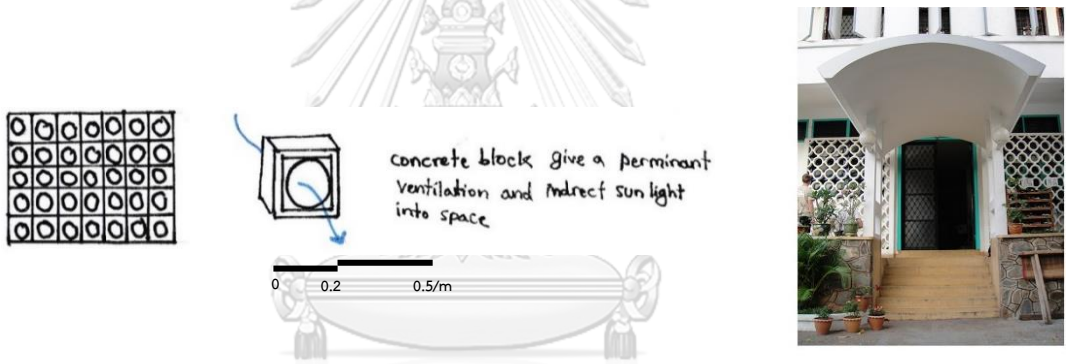


Figure 2. 63 Detail drawing of the concrete ventilation block of the building. (source; Vann Molyvann project)

2.2.12 Olympic Village Apartment (Grey Building)

Figure 2. 64 Olympic Village Apartment (Grey Building) in 1963 (source: Vann Molyvann Project)

The Olympic Village apartment was a spectacular piece of architectural genius that towered up to the eighth floor. However, it has since lost most of its original glorious design under the influence of a new developer. The building had a robust foundation that offered it adequate stability. It was constructed based on the Front de Bassac Master Plan, used for buildings with high-density housing. The grey building acted as an experimental venture that mirrored urban lifestyle (Fig. 2. 64). The traditional Khmer lifestyle and the Unites offered key influences for the construction of this apartment building. Khmer houses' designs are characterized by features, which include public spaces, such as a verandah, living room and bedrooms, servant quarters, an underground, dependence, and the kitchen (Kosuke, 2016). The building was developed in the period 1960 and 1970.

The grey building had three apartment typologies, revolving around loggias and stairwells. The loggias were used to separate the dependence from the bedrooms as well as to allow the diffusion of air and sunlight into the apartment. The building has voids that alternate on each level, to create a social space, enabling neighbors above and below to interact. The voids are located next to loggias, and this results in a double-heighted space, which provides ample direct light. The apartment was

constructed to allow occupants to control the quality while maintaining an adequate airflow. Natural ventilation in a multi-storied building is indispensable. Architects find it critical for the purpose of health and the thermal environment. The designers of the Olympic Village apartment (grey building) accomplished it by adding voids (loggia). The voids pave the way for natural forces, such as wind and buoyancy to take their course. The forces drive in the cool outdoor air through spaces as the hot air is eliminated. The spaces also promote healthy living while reducing energy consumption at the household level. Additionally, the alternation of voids on each level creates social spaces. The occupants can interact with their neighbors living on the floors above and beneath. In this way, the voids are critical not only for health but also for the psychosocial well-being of the residents (Fig. 2. 65).

The building was described as 'superposed villas in a vast garden' by a consulting architect, Guy Lermachands. The building was designed with the aim of housing athletes participating in the 1963 Southeast Asian Games and eventually was used to host the U. N. experts instead of the athletes (Ross & Collin 2006). The Grey building was purchased by a developer, U. N., 1994, and was converted into an office complex for the Phnom center (Fig. 2. 66).

Figure 2. 65 Diagram drawing analysis of the unit floor plan and section of the building

Figure 2. 66 Present Olympic Village Apartment (Grey Building), (source: Phnom Penh Center

2.2.13 One Hundred Houses

Figure 2. 67 One Hundred Houses project (taken by author, 08 March 2018)

The One Hundred Houses project, inaugurated in 1965, consists of 100 identical homes, with a clear delimited plot built on the 6.5 hectare site located in Tuk Thla, Phnom Penh (Fig. 2. 67). Its initial intended function was providing housing for the National Bank of Cambodia staff. The building presents a fusion of traditional rudiments and modalism, elevated and plan drawing, directly inspired from the Khmer traditional houses, incorporated with modern materials and utilities with an understanding of the different typologies and the socioeconomic effect that would be beneficial for inspiring future housing development (Nickish, 2012). The One Hundred Houses project was designed taking into account tropical climatic conditions. The houses and gardens were designed and built in a checkerboard pattern on a site. Each individual house contained openings in all directions for view, ventilation, and privacy. According to the design, the houses are not aligned in a straight row, but instead, the houses are placed, one shifted to the front and one backward. The houses that were shifted to the front contained gardens at the back, while in houses shifted to the back, the garden was at the front. This allowed all residents to only have the garden for the view and not the inside of other houses from their windows (Fig. 2. 68).

The foundations, floor, and columns were made with reinforced concrete, while the roof was wooden, with earthenware tiles. There is no glazing, but the windows are equipped with a wooden louver (Fig. 2.69). The dwellings are set on stilts raised off the ground for security and to protect from floods in the rains; at the same time, they allow cool air in the area below, creating a favorable place for the holder to utilize the ground level, for purposes such as working and meetings.

In addition, the design of the roof is meant to permit air to circulate under the roof space and escape from an opening at the tip, cloistering the living space underneath to insulate and cool down the house, thus differing from the original Khmer house structure, in which, air circulated straight through the building, but the roof did not get cooling directly (Fig. 2. 70, 2. 71).

Moreover, the transformation of the houses was imminent because of the evolution of the modern way of living as a result of understanding the various typologies and impact of socioeconomic of the recent times. The socioeconomic effect is felt in regards to the expensive nature if living in big cities and so there was the need

for transforming the houses to cope up with the current trends. Moreover, as the individual families grew in number, there was the need for acquisition of more units which were bigger to accommodate the growing numbers.

Figure 2. 68 Houses and gardens was design and built in a checkerboard pattern on a site (source: A+U Magazine)

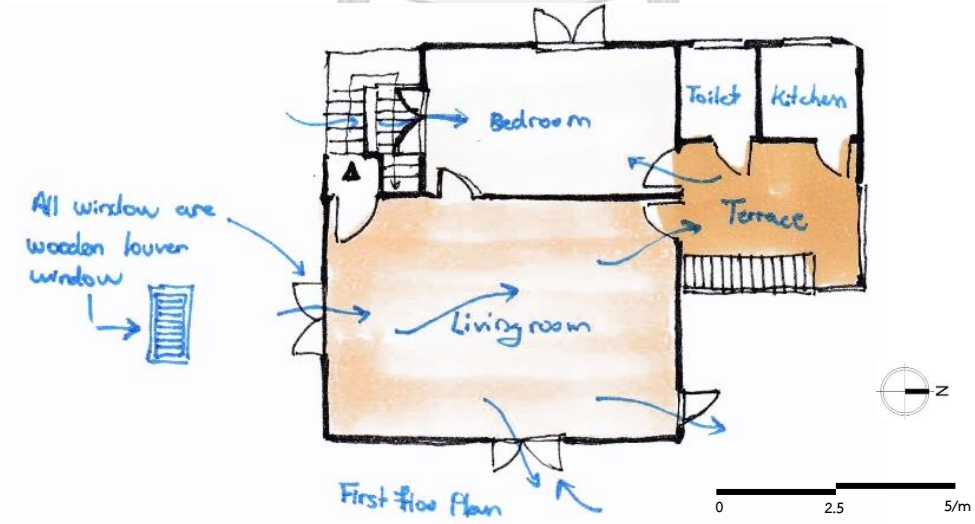


Figure 2. 69 Diagram analysis drawing showing the function and air circulation of the house

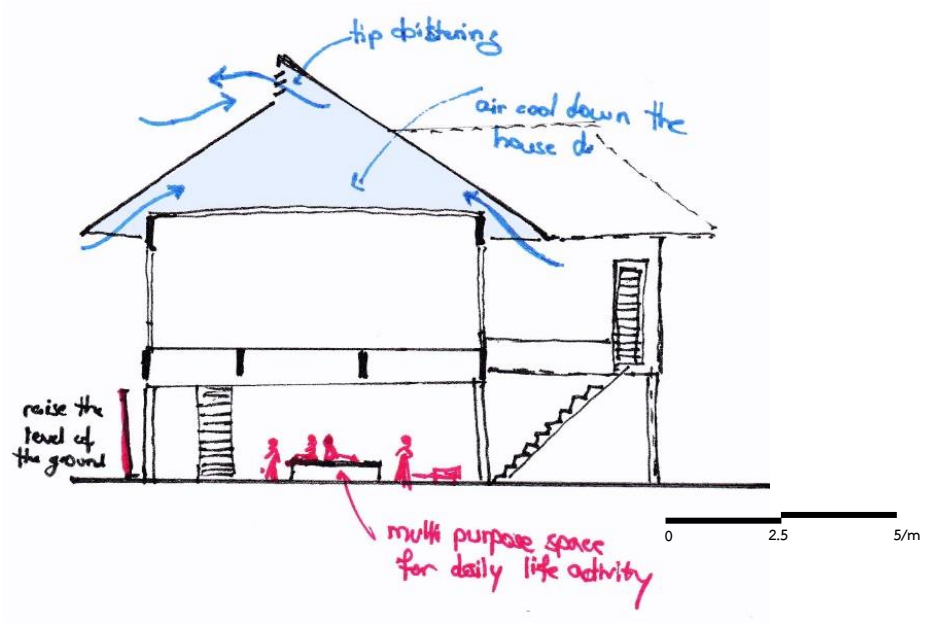


Figure 2. 70 Diagram drawing analysis displaying how the roof permit air circulation above living space underneath

Figure 2. 71 Livingroom and bedroom of the house (source: A+U Magazine)

2.2.14 Vann Molyvann House

Figure 2. 72 Vann Molyvann House (source: A+U Magazine)

It was designed alongside Walter Amberg and completed in 1966. It is a three-storey building, located in Mao Tse Tung Blvd. in Phnom Penh. It served as an office and residence for Vann Molyvann (Ross & Collins, 2006). The building has a distinctive design: its roof is shell structured, an exercise in the hyperbolic-parabolic curves. The main structure of the building is reinforced concrete with brick facing (Fig. 2. 72). The building has a double roof concrete shell, a regulated structure, impervious to water and enclosed with a flat terracotta tile on the outer surface and with wood on the inside. The double roof reduces the heat from the direct sunlight (Fig. 2. 73). The corners of the square roof are self-supporting and turned upward, implying that merely four columns are situated in the middle of every side, holding it up. A roof of this kind provides ventilation and lighting (Fig. 2. 74) (Sereypagna, 2017).

The walls of the building are finished with the red bricks, making it more visible. The house has glass surfaces. Nonetheless, there are concrete louvers on the first floor

that block direct sunlight (Fig. 2. 75). Moreover, there are balconies on the second floor and deep eaves on the third floor that block direct sunlight. The exterior of the building includes double brick walls, with the ventilation layer for discharging the warm air (Fig. 2. 76). Such architectural decisions protect the building from the tropical heat. The building is raised on stilts to keep a distance above the ground in order to protect it from damage by waves, water, and shifting sand or soil (Sereypagna, 2017).

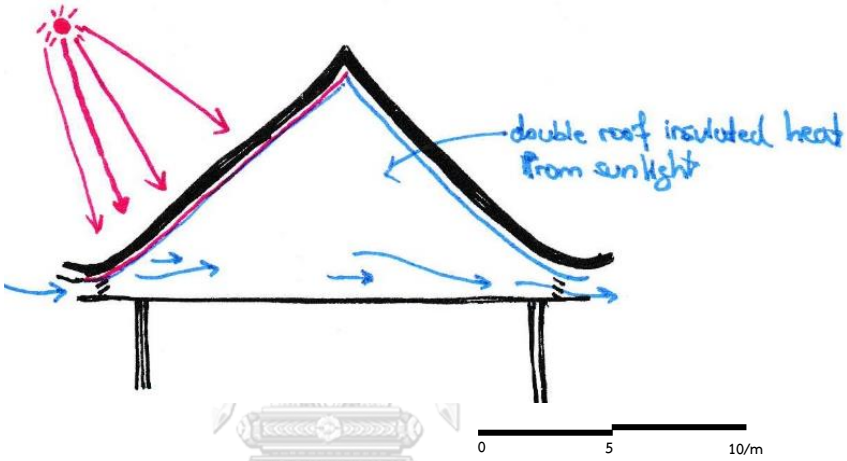


Figure 2. 73 The double roof limits the heat caused by the direct sunlight

Figure 2. 74 Double roof concrete shell structure (source: New Khmer Architecture book)

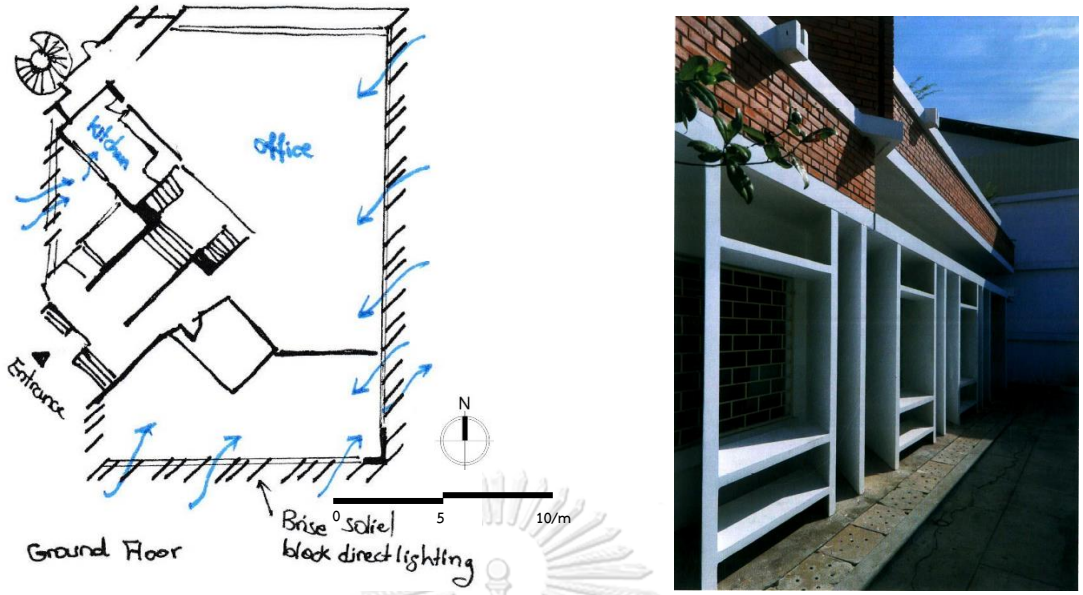


Figure 2. 75 Concrete louvers on the first floor that block direct sunlight (A+U Magazine)

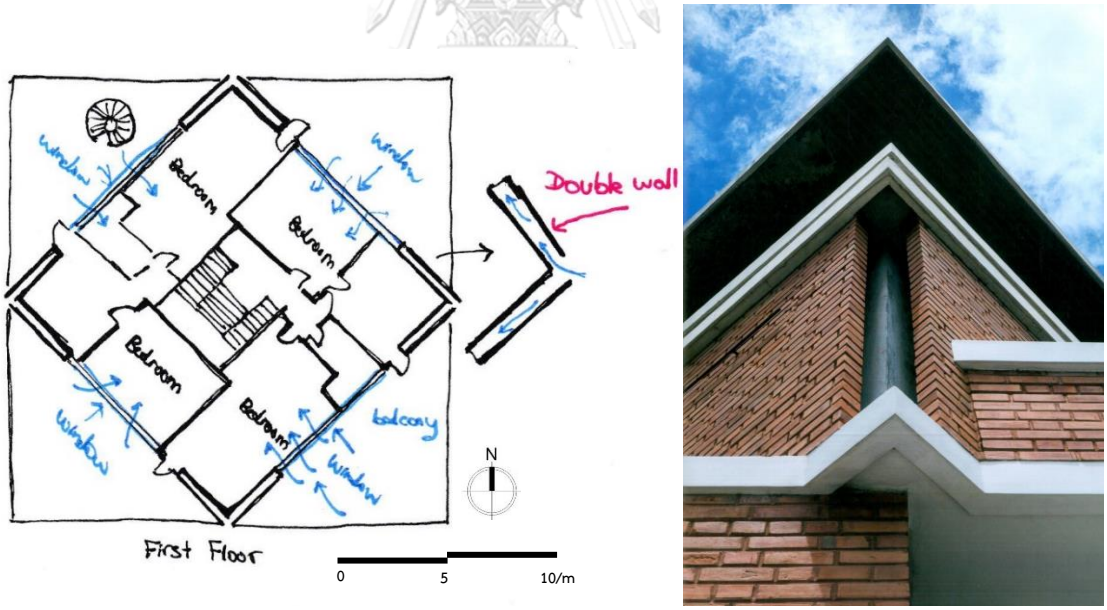


Figure 2. 76 Double brick walls with the ventilation layer to discharge the warm air (A+U Magazine)

CHAPTER 3 TROPICAL STRATEGY OF MODERN ARCHITECTURE IN CAMBODIA

Vann Molyvann's designs represent architectural masterpieces that share some central features and some differences; they are skillfully designed with an intent or purpose, such as the ones stated: the 13 buildings investigated in Chapter 2 share some common important features, such as the water system, walls, and ground elevation. The architectural design employed in Vann Molyvann's works form a depiction of modern day architecture. This paper therefore analyzes the architectural works in relation to the features they share, as possible strategies to make structures that can sustain in tropical climate and offer a comfortable environment to the inhabitants.

3.1.1 Water

In general, most of the architectural works have good water management systems. Of the 13 buildings assessed in this case study, six use precise techniques for drainage and water management. These six architectural works include the Central Bank branch located in Sihanoukville, the National Sports Complex, State Reception Hall, Teacher Training College, and The Preah Suramarit National Theatre. These architectural works are categorized either in relation to their drainage and water management system or their level in relation to the ground. The drainage of the Central Bank branch located in Sihanoukville is outside, on the front part of the building, and is used for collecting rainwater. Second, the National Sports Complex has good drainage within the facility. It houses shallow storage ponds connected to the roof, in which, rainwater accumulates during storms to prevent flooding and is then drained out at a slower pace. Moreover, the water collected in these ponds is used as a coolant during the tropical climate. To achieve this, the water accumulated at the bottom of the ponds is exposed to extremely low temperatures. The freezing cools the buildings' floors. Water collected in the ponds at the top of the buildings is exposed to direct sunlight during the tropical climate. The water evaporates and carries

the latent heat of vaporization in turn. The evaporation causes a cooling effect on the roofs of the buildings, hence allowing a cool atmosphere in the interior.

The ground level of the Chamkarmon palace is a rectangular pool that drains away rainwater. In the One Hundred Houses project and the SKD Brewery, the buildings are raised off the ground on stilts to protect from flooding. The bottom of these buildings also contain water, which cool the buildings through mechanisms explained above. Additionally, the foundation of the Teachers Training College, now known as the Royal Campus, is also raised to prevent flooding in the rainy season. Underneath it, there are storage water ponds, which permanently hold water, and the walkways throughout the campus allow people to move over the pools of water. The Preah Suramarit National Theatre has a pool in its basement level, collected from rainwater, and it serves to provide cooling in the theatre. The pools of water also provide a mechanism for cooling, especially when temperatures are high.

The water storage locations also provided water reserves during the dry season. Although the tropical climate is typically hot and wet, the temperatures rose above the optimum temperature quite commonly. In such cases, the harbored water was released to the environment to balance the humidity in the atmosphere.

3.1.2 Level off the ground

One other main feature of Vann's works is their elevation in relation to the ground; most of them seem to share this feature. The majority of Vann's buildings are raised above the ground using stilts. The significance of the buildings being relatively raised off the ground is that apart from preventing damage by floods, which occurs in the rainy season, the raised platform provides security and creates a cool environment, as it shields from the tropical monsoon climate that is experienced in Cambodia throughout. This coolness facilitates the free circulation of air in buildings. The space created on the ground also opens up an area for alternative activities, such as parking, and also simple factories, such as welding or even communal children's playground. It is also imperative to note that this elevation allows free circulation of air, hence ventilation, from beneath the building. The ventilation helps maintain a constant room

temperature by maintaining a constant concentration gradient with the floor of the buildings and the air or water beneath the building.

Out of the 13 buildings under Vann Molyvann's name, eight are designed in a level relatively raised off the ground, i.e., the SKD Brewery, the One Hundred House project, the Teacher Training College, Sangkum Reastr Niyum Exhibition Hall, Molyvann's house, and the Chaktomuk Conference Hall. The Preah Suramarit National Theatre is also raised on stilts, such that access into the premise is from beneath a triangular concrete fronton. The basement level houses the pool. The Norodom Sirivuth's mother's house was no exception, only that it was only slightly raised, with the building being in actual contact with the ground. This design ensured that the building was anchored on the ground while at the same time allowing the free circulation of air. Like the theatre, the Chamkarmon State Palace reaches the ground through a concrete wall that is circular in shape, in order to form a courtyard, which also accommodates a pool.

3.1.3 Wall

A good architectural work entails well-constructed walls; one of the most common wall structures being the double/perforated wall structure. Out of the 13 architectural works by Vann, 6 contained double walls. The SKD Brewery has double walls with huge windows to allow direct sunlight to filter in and also give those inside the opportunity to view the outside. A red brick wall is preferred for the outer wall, with free space separating it from the inner wall, which is made of concrete. The goal of the double wall is to ensure that the heat from outside is not transmitted into the building through the inner wall. The backside of the Central Bank building has prefabricated concrete screen walls that facilitate the entry of indirect sunlight and proper ventilation.

The National Sports Complex has a single wall with large holes running through it to provide ventilation and lighting. Similarly, the Preah Suramarit National Theatre lacks windows, but instead, it has wall cladding in hexagonal shape for ventilation and lighting. In the Teacher and Training College, the classrooms are set apart by screen

walls while the corridors are adorned with perforated walls to bring in light and fresh air. Double walls separate the classes from the external environment. Like the brewery, red bricks are used in the outer wall, the inner wall is made of concrete, and an air gap is left in between. There are also windows that provide a good view of the outside and allow light in. The external wall of the State Reception Hall is also double layered, made of natural stones and concrete pillars.

Despite their different architectural structures, perforated walls mainly perform similar but still distinct functions. The shared capabilities of the walls include shielding against direct sunlight, provision of shade to the interior, ventilation, and visibility of the surrounding. One of the most wonderful architectural designs of the buildings is exhibited in walls made of prefabricated concrete blocks. The walls were a replacement for windows, and they were hexagonal, forming a wall cladding. Such walls provide leverage over other walls, since they also shield buildings from the rain. Additionally, the walls are versatile, since they exist in different colors and designs. Therefore, they blend appropriately with a range of buildings. The uniqueness of prefabricated walls exhibit their robustness despite the wide perforations. Hence, they provide more room for visibility in and out, ventilation, and block direct sunlight from entering the buildings.

Other walls are made of brick, as evident in St. Michael's Catholic church. The building constitutes latticework, both on the sides and end of the buildings. The design allows mild breeze as well as light to enter the church. Additionally, bricks add on to the aesthetic beauty of buildings, can be modified into a variety of designs, and are cheap to install. During summers, bricks provide a cooling effect to the buildings, since the most constituents evaporate leaving a cooling effect.

The Teacher Training College contained perforated hallway wall, allowing indirect light and ventilation into the building. The eastside classrooms had perforated sidewalls illuminated by natural light. The walls also prevented external distractions.

3.1.4 Roofing

Four out of the thirteen structures implemented the double roof design. SKD's roof is also double layered and flat to prevent the transmission of the heat from the sun into the building. The roof is also flat to allow free flow of air through the structure. The bank's roof is similar to SKD's only that its pergola that is concrete-based is massively raised from the conventional roof providing a shaded external area. St. Michael's Catholic church has a single roof that is extremely high and has an open ceiling. The roof of the auditorium of the Preah Suramarit National Theatre is also extremely high and flat. The front of the building has a triangle- roof to permit the entry of light from the side rather than directly from the top. The One Hundred Houses have wooden roofs lined with earthenware tiles. This format allows circulation of air below the roof, allowing it to leave through a peripheral opening.

Similarly, the roofs of the State Reception hall (V-shaped) and Teacher Training College (V-shaped, honey comb-shaped) are also double layered, to maintain a serene atmosphere within the rooms. They are also spacious to keep the outer layer from transmitting heat to the inner roof.

Another design of the roof has been depicted in the model of the national bank. The rooftop has been reinforced with concrete, and it adopts the architectural designs of the lattice. The butterfly design shields the bank's roof from direct sunlight. Additionally, the roof provides shade to the building due to its shape.

The flat roof is a controversial issue in architecture. However, Vann Mollyvan incorporated a flat roof in the construction of the SKD Brewery office. The strategy gave the building additional aesthetic beauty, since the design was less popular. However, it was difficult for the building to survive heavy rains without leaking rainwater to the interior of the building. To resolve the issue, Vann used the idea of double walls. Rainwater that leaked through the top concrete roof was contained above the second roof. Due to the high temperature that exists between the walls, the rainwater evaporates and runs into the atmosphere via the perforations at the sides of the roof. Another strategy of dealing with the challenge is the incorporation of slightly sloping but not entirely pitched roofs. The slopes are directed toward a common gutter

connected to a valve that runs to the ground. This is evidenced in the construction of the National Sports Complex. The mechanism of the rooftops constructed using the architectural design collected rainwater in the roof through the slopes into the valve, then to a pool in the ground, which served as an underground coolant.

Similarly, it was possible to construct raw concrete without necessarily adding a sheet membrane over the rooftop. In this case, the rooftop became non-porous to rainwater in way that it could still hold water. The sides of the roof were then raised to create a pond in the rooftop. The ponds had overflow valves to regulate the amount of water contained in the ponds. Therefore, the pond harbored rainwater, providing additional cooling to the building.

3.1.5 Shading

Shading is one of the most important features in the architecture of Vann Molyvann. Various features shield buildings from direct sunlight. The double walls of the Teacher and Training College shelter the classrooms from the direct sunlight and so does the honeycombed roofing system, which only allows light to penetrate through the sides and not the top. The Norodom Sirivuth's Mother house Vann designed in such a way that it was protected from direct sunlight by cantilevers placed on the upper levels of the lower floor and vertical shades on the upper floor. The vertical panels could be adjusted through tilting to let in air and light. The State Reception hall has a roof with multiple peaks, allowing indirectly sunlight. The Sangkum Rests Niyum Exhibition wall on the other hand has walls designed like wings with deep weaves and fall beyond the past the walls preventing direct sunlight. The double roof and the concrete louvers on the first floor of Vann's house prevent this.

3.1.6 Program and Orientation

Considering the tropical setting, Vann carefully considered his designs for dealing with the tropical climate. Some of Vann's designs with essential strategies dealing with the tropical climate have been described below:

SKD Brewery

Vann Molyvann strategically placed the brewery windows on the west side facing the road, giving the user an opportunity to adore a pleasant view.

The windows face the east, allowing early morning sun rays to penetrate the brewery, thereby reducing the mist cold. The sun rises from the east; thus, Vann Molyvann placed the skylight on the rooftop facing the north-south direction, thus allowing proper ventilation in the brewery from the skylight's side louvers.

The Church in Sihanoukville

Since the church's entrance faces the south-west direction, no direct sunrays enter the church regardless of whether it is hot. This ensures that church does not experience extreme heat. In Sihanoukville, the wind blows from south-west to north-east; having the church doorway facing this direction allows a lovely cool breeze to enter the church. Additionally, Vann Molyvann placed pre-fabricated ventilation blocks in this same direction, on both the entrance and at the back of the church, thus allowing good air circulation.

The National Sports Complex

For indirect sunlight, Vann fitted the eastern side of the complex with light screens. Similarly, the exterior part of the roof provides shade for the outdoor audience.

In addition, on the opposite side of the sports complex, Vann incorporated three separated pendulous roofs on the topmost eastern side of the stadium. Thereby, it offers shade for the spinning complex on the eastern slope and reverberates the interior stadium's roof.

Chaktomuk Conference Hall

In this design, Vann incorporated bioclimatic features, such as shading, by providing a curved veranda. Additionally, for better ventilation form west to east, from the ground floor flowing up towards to the backstage, and east to west from the back

of the building flowing underneath the stage towards the seating areas, Vann lifted the building off the ground with open spaces.

Moreover, Vann placed the exit points on the east side of the building, which happen to be the back of the building, where the audience may leave or enter the stadium from, without causing any disturbance during performances. Similarly, since the wind blows from the south, the elevation foyers were placed in the southern side of the building, with narrow openable windows to allow ventilation.

Teacher Training College

Vann linked the central hallway with perforated wall to the classrooms in the western and eastern sides, allowing indirect light and air ventilation, thus causing less external destructions. Furthermore, to provide more shade to the classes, the main building and the library were constructed on the eastern side of the classrooms.

Vann also incorporated skylights facing north-south direction, thereby providing proper ventilation and penetration of early sunrays into the main building. Vann positioned the central façade in the north, which opens onto a courtyard, while the forest trees provide cooling air. On the southern side, the façade has a concrete panel that is open, thereby shielding the corridor from direct sunlight.

The State Reception Hall

Vann introduced a double V-shaped roof facing north-south direction to allow sufficient airflow in the building. Additionally, the eastern part of the hall has a concrete wall with a circular ground design, which not only yields a gentle and dappled light into the structure but also provides ventilation. Vann also fitted the design with a picked tower louvered in all directions, north, east, south, and west, to provide further ventilation and indirect sunlight to enter the structure.

Sangkum Reastr Niyum Exhibition Hall

On the eastern and western sides, Vann provided deep eaves and wing walls to offer shade from direct sunlight. To allow sufficient light to enter the exhibition

room, the white painted concrete wall was sheathed in non-painted red bricks, and the windows ran in vertical strips at the corner of the building.

Preah Suramarit National Theatre

In designing this masterpiece, Vann did not hold back his imagination. The design does not contain windows. It does however have hexagonal, prefabricated walls that resemble fish scales. Placed on the western and eastern sides of the theatre, these 'fish scales' not only offer sufficient ventilation, but also allow indirect lighting. Additionally, Vann supplied a triangular skylight on the roof. This skylight was louvered on all three directions to help resolve the lighting issue and contribute to the structure's aeration.

The House for Norodom Sirivuth's Mother

On the eastern and western sides of the house, Vann incorporated double walls to increase the ventilation and limit the amount of direct sunlight entering the house. In addition to the balcony all around the house, these provisions allowed the creation of a calm environment. Similarly, on the eastern and western sides, concrete ventilation blocks offering indirect lighting were installed, which facilitated ventilation as well.

3.2 Findings

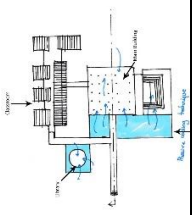
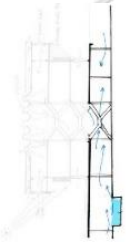
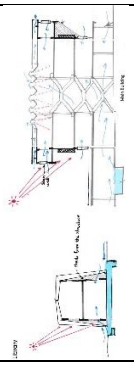
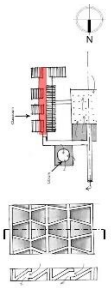
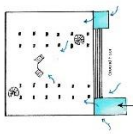
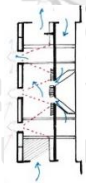
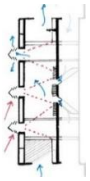
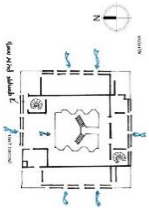
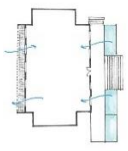
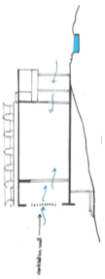
Finally, from all his works, it is clear that Vann Molyvann carefully considered the project's purpose, ventilation, the viability of a cooling system, the role of water, and most importantly, the demands of a tropical setting. The climate of Cambodia is hot and wet, and Vann understood this completely. In his projects, his designs collected rainwater and used it to cool the building, and in the case of the National Sports Complex, the pool was used for this purpose.

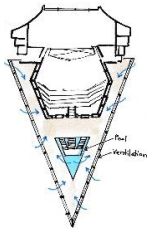
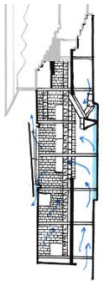
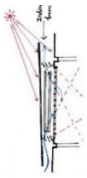
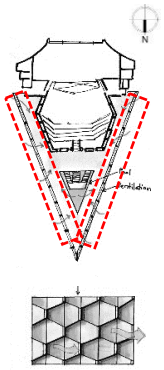
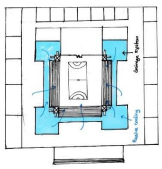
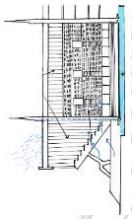
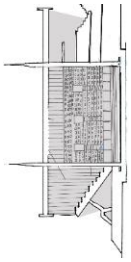
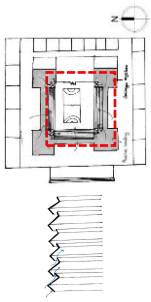
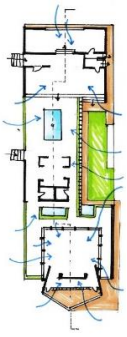
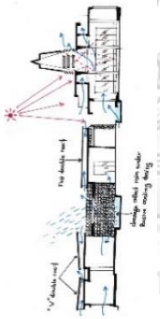
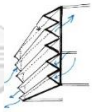
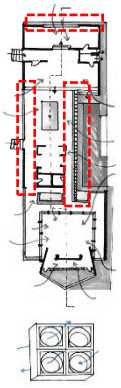
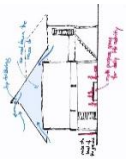
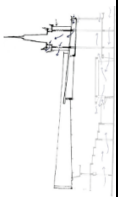
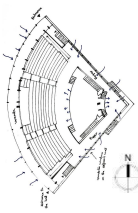
With regard to the hot climate due to the tropical location, Vann employed prefabricated walls on the eastern and western sides and skylights facing the north-south direction on roofs to allow sufficient ventilation. In order to protect the buildings

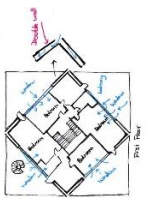
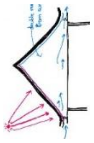
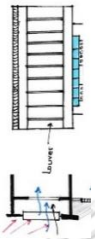
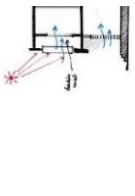
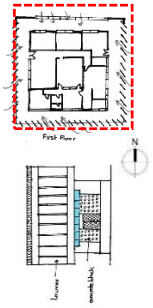
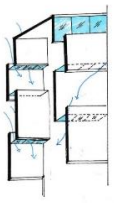
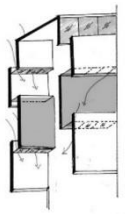
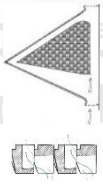
from the frequent flooding in tropical areas, most of Vann's designs were set on stilts, to give them some elevation above the ground. In light of these measures, it is evident that Vann Molyvann did not only care about the buildings' structure in relation to the tropical climatic conditions, he deeply considered the problem in its entirety.

All the elements employed in Vann Molyvann's style for dealing with tropical climate can be summarized as presented in Table 1 here.

Table 1. 1 Summary of Architectural Elements: Drawing Analysis

Project	Water	Level off the ground	Wall	Roofing	Shading	Program/ Orientation
Teacher Training College						
SKD Brewery						
National Bank Sihanoukville					•	•

Preah Suramarith National Theatre				•		
National Sport Complex				•		
State Reception Hall					•	
One Hundred Houes	•		•	•	•	•
Chaktomuk Conference Hall	•		•			

Vann Molyvann House	•	•			•	•
Norodom Sirivuth's Mother	•	•		•		
Sangkum Reastr Niyum Exhibition Hall	•	•	•	•		
Church Sihanoukville	•	•		•	•	•

3. 4 Conclusion

The spectacular building designs examined in this study have demonstrated extremely important strategies to with tropical climate through the incorporation of, primarily, natural ventilation and reduction in the amount of direct sunlight entering the buildings' central space, instead of using modern air conditioning. Although the

tenets of Vann Molyvann's tropical architecture are extremely similar to the region's vernacular architecture, his strategies were realized through techniques of modern architecture languages imported from non-tropical climate zones, thus making them points of interest in the study of architecture. These examples could be exploited as references for contemporary architecture for creating better sustainable designs for the country and perhaps the whole region.

Despite the uniqueness of the designs presented, the architectural systems have notable challenges. The double roofing and double wall system has problem with accessibility and difficulties in cleaning the spaces in between the double structure. Since it is not possible to clean the area substances that get trapped in the spaces, and this provides viable conditions for birds and other animals to live in. On that note, the flow of air may have interrupted, as a result, the temperatures are not appropriately regulated making the room hot. Consequently, more significant spaces are required to hold more water in the underground pool to collect the rain water and adjust the temperatures of the room to the desired climatic conditions. This drainage system which can lead to breeding of mosquitoes, growth of algae and moss because water stagnates in the open posing a health hazard. Moreover, algae and moss prevent movement of collect water, and the pool are expensive to clean and requires frequent maintenance to inhibit overflow of excess water. In brief, the architectural designs come with many advantages, but also contain various drawbacks that have been noted that make it attentive for use when building a building.

CHAPTER 4 CONTEMPORARY ART AND ART SPACE IN CAMBODIA AND THAILAND

4.1 Contemporary Art in Cambodia

Contemporary Cambodian art, in its current form, has gone through numerous phases to guarantee its revival after the long struggle for independence since 1953 and propose areas for enhancement. Cambodia's thriving cultural heritage was almost lost in the horrific devastation and genocide by the Khmer Rouge throughout the Killing Fields between 1975 and 1979. The arts in Cambodia assisted Cambodians in getting back their cultural heritage and restoring health for the upcoming renaissance. It was important for Cambodian art to be modified with a view to returning and preserving its cultural heritage. Numerous artists have made an effort to preserve the true image of Cambodian's past through artistic expression.

Nevertheless, their resources are limited and they have been struggling to carry out the revival (KRICH, 2017). Research indicates that Cambodia lacks appropriate art spaces, resulting in the loss of Cambodian culture. The small shop houses are poorly lit, do not have ventilation, cannot accommodate a large number of people, and function without any supporting facilities, services, and proper environmental control system. Contemporary art space in Cambodia is mainly run by artists or young generation artists in non-commercial public buildings that are not run properly. Some of the art space can be operated only partially because of lack of funding to pay electricity bills and install air-conditioning systems, which makes the building uncomfortable to be in. At the same time, the buildings are mainly educational and cultural places that are vital for future citizens.

The brutal regime of Khmer Rouge has certainly cast a shadow over Cambodia's cultural heritage. The arts in Cambodia were proscribed from 1975 to 1979, and numerous musicians, dancers, artists, and filmmakers were targeted and exterminated. In the 1980s, the few artists that had lived on were encouraged to return to the capital from different places across the world to pass on artistic traditions, which could have vanished and been forgotten. Although the efforts to revitalize the traditions have

continued, emerging artists intend to develop their own styles in the future. Modern Cambodian arts vary from the recollection of the vast historical period of Angkor, through the horrors of warfare and its consequences, to the globalization of the early 21st century. A t present, the customary forms of art utilized for temple decoration and puppet designing are being learned. The robustly Western style of painting can be found in numerous works portraying subjects including national pride, war, and other genres. Some Cambodian artists are operating in a more completely current framework, frequently utilizing blended media as well as computer technology. It would be a disservice to envisage Phnom Penh with its successful cultural scene as a city confined to its ancient times. The modern Phnom Penh has falsified its own identity, since the abundance of galleries, festivals, and concerts in the city are a demonstration of the resilience of its inhabitants (Nelson, 2012).

Even though Cambodian contemporary art has experienced some significant changes, there are more exhibitions in other countries. Therefore, there is a need to establish a proper art space to serve as a central link for the country's contemporary art. Such a place will unite people from the various communities and even from other countries, with an interest in art. The current contemporary art space in Cambodia does not generate income, but has some kind of cultural value. Currently, these art spaces and Cambodian art have begun to be noticed internationally, but locals are not yet aware of the change because there is no proper and significant easily accessible space for the public to host contemporary art activities. (Post, 2017).

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4.2 Contemporary Art in Thailand

Currently, contemporary art in Thailand depicts the nation's intricate and rich cultural heritage through fresh and motivating ways. Thailand enjoys a flourishing literary and film industry in addition to the visual arts (McDaniel, 2017).

Over the last decade, young and promising Thai artists appear to have developed a range of visual interests and techniques through which they demonstrate their artistic inclinations. The new media, specifically computer-centered and digital artwork, for instance, is utilized together with traditional mediums that include leather

carving, a relatively vernacular practice. Figurative paintings are generated alongside technically refined installations, which integrate aesthetic pleasure with the values of the community (Chapakdee, 2017). The most widespread tendencies of the 21st century art practices in Thailand seem to primarily emphasize faith or spirituality, which is alluded to as the force governing over the cycle of life and death. Nonetheless, it is also considered and embraced as a way of political critique of social issues, frequently expressed in the form of social dislocation and cultural dysfunctions. Besides mixed media installations and painting, the language preferred by the younger generation in Thailand is the new media. The youth are broadly exposed to technological advancement apparatus comprising Twitter, Facebook, and smart devices that entirely facilitate and emphasize the utilization of technology in their practice of art (Taylor, 2008).

Thailand is still a profoundly traditional nation, and the influence of Buddhism and cultural traditions are portrayed in the works of numerous modern artists. The art scene in Bangkok is still, to some extent, disjointed in comparison to other cities, with numerous galleries being distant or touristy (Mukdamanee, 2008).

The study examines the contemporary art space in both Cambodia and Thailand with regard to accessibility, art space control, service, supporting facilities, and sustainability. Furthermore, it compares and contrasts the modern art space in Thailand and Cambodia and illustrates the manner in which relevant solutions can be obtained for both Cambodian and Thai contemporary art space.

4.3 Analysis of Contemporary Art Space in Cambodia

4.3.1 Case study of Romchiek 5 art space in Battambang

Romchiek 5 was established in 2012 by four artists, BerHak, Hour Seyha, NgetChanpenh and Mil Chankrim, and expanded in 2015. The art studio is situated on street 201, Battambang province, Cambodia (Fig. 4. 1). The art space focusses on exhibiting art at the showroom, acts as a museum, and an art studio. The space is about 240 square meters in size, restricting movement within the facility. In order to make use of the little space available, the building uses vertical space, with an

additional floor constructed to make more room for exhibitions, as shown below (Fig. 4. 2, 4. 3).

Although the art gallery is visited by local and foreign tourists, the building is not suitably situated — it seems very private and unapproachable, an impression that is made worse by the fact that there are limited access routes to the studio. The available roads are tiny and in very deplorable conditions, making it hard for prospective clients to access the building. You can see a graphical depiction of the studio and its poor location below (Fig. 4. 4).

From its exterior, the studio is generally unwelcoming and distasteful and represents a precarious environment. There is a lack of auxiliary facilities and suitable storage. Limited space within the facility does not allow easy movement. Romchiek 5 was expanded from a workshop to a gallery in 2015, and has a permanent collection on the second floor displaying works of its co-founders, who were expelled from Thailand, forced into child labor, and later rescued by donors who advised them to express their thoughts and feelings through art. The art space is financially manageable in term of energy consumption because the natural light for the art space comes through the glass block clerestory or side lighting. The space has a vent that provides natural ventilation for the building. However, the building appears to be a private house, It is unappealing as most people would be afraid to enter and lacks of a parking space.

Figure 4. 1 Location of Romchiek 5 gallery from the city center (left)

Figure 4. 2 View from the street toward the gallery (upper right)

Figure 4. 3 Exhibition space of the gallery. (lower right)

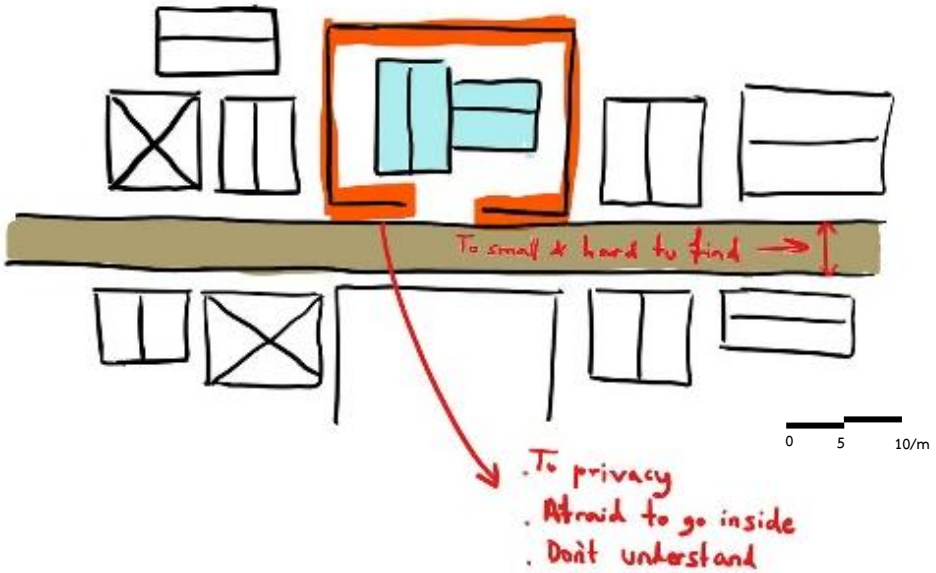


Figure 4. 4 Diagram analysis issues of the gallery building

4.3.2 Case study of Sangker art space in Battambang

Sangker art space was created in 2011 by a group of French and local artists to display various designs through art. It is owned by a Khmer group of artists who have created a variety of artistic arts and visited by both local and international tourists. Shown below is the exterior view of the art space. The gallery studio is in street 1590 in Battambang, located in the city center. The close proximity to the central business district (CBD) makes it strategically located for easy access.

The studio is about 104 square meters in size. The gallery room, which contains most of the pieces and works, is located on the first floor, accessed through a moderately narrow staircase (Fig. 4. 5). The building is too elongated and dimly lit, as it lacks openings to allow natural light into the building. Therefore, it relies completely on artificial light.

Notably, the space lacks mechanical ventilation on the inside as well as suitable storage facilities. Nevertheless, it is fairly accessible with a small road network. There is no parking area for clients that might want to use their personal vehicles. The design of the structure, both outside and inside, is largely unappealing due to the unsatisfactory lighting and ventilation. The facility accommodates a passageway and a gift shop that allows both local and international tourists to purchase souvenirs, especially the handmade collections (Fig. 4. 6). The art space lacks fire protection and security systems and the limited space hinders flexibility. Presumably, the gallery is not financially viable since it does not utilize natural lighting and ventilation; instead, it relies on artificial lighting that is insufficient to cover all the rooms (Fig. 4. 7, 4. 8).

Figure 4. 5 location of Sangker gallery from the city center (left)

Figure 4. 6 View from the street toward the gallery (upper right)

Figure 4. 7 Exhibition space of the first floor gallery (lower right)

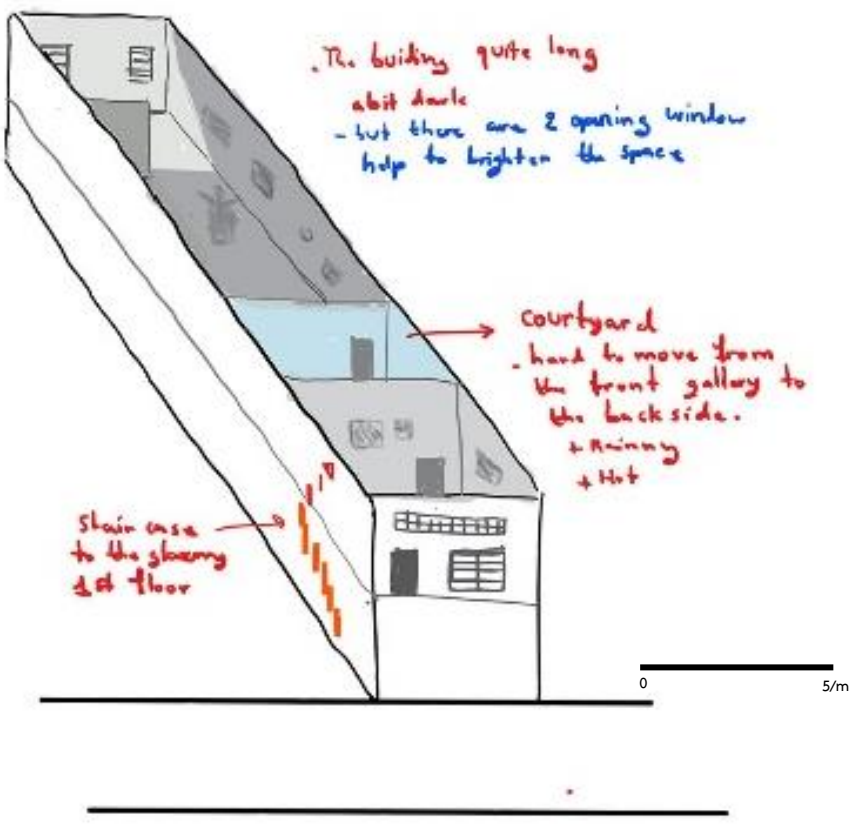


Figure 4. 8 Diagram analysis issues of the gallery building

4.3.3 Case Study of Khmer Kid Art Gallery art space in Siem Reap

The Khmer Kid Art Gallery was established by a Japanese art teacher in 2015. The gallery building is situated along Bamboo Street in Siem province. The building is located approximately 600 m from the city center and is 192 square meters in size (Fig. 4. 9).

Mainly, it serves multiple purposes for both local and international art lovers. The building is mostly used as a showroom for different masterpieces and sculptures, a workshop where designers and artists carry out their creative activities, an art class where enrolled students and prospective artists are taught art and craft to sharpen their skills, and as a gallery where transactions take place, as illustrated below (Fig. 10).

The art class is located on the first floor of the building and equipped with various learning materials. The art space belongs to the Khmer art. The building has a private gate, which makes it look like private property. Inside, the internal space is narrow and each section is separated by partitions. The separations limit space within the gallery, which in turn inhibits flexibility and movement as shown below (Fig. 4. 11).

The collection of paintings is mounted on the sides of the partitions to make use of the limited space within the gallery store. The art space has various creations placed within the gallery store, which contribute to the building's disorganization. The building, like many others, fails to make use of natural lighting leading to poor illumination of the rooms. There are no mechanical ventilation openings within the building to facilitate sufficient air supply and circulation. The gallery situated in a small street; hence, fewer people are able to reach it. There is no parking space within the facility. The art space lacks a fire alarm system. There are no auxiliary facilities and not enough storage capacity for tools, equipment, and drawings. In general, the gallery is unconducive and unattractive due to its design in terms of poor lighting conditions, inferior ventilation, and the aloofness of its environment (Fig. 4. 12).

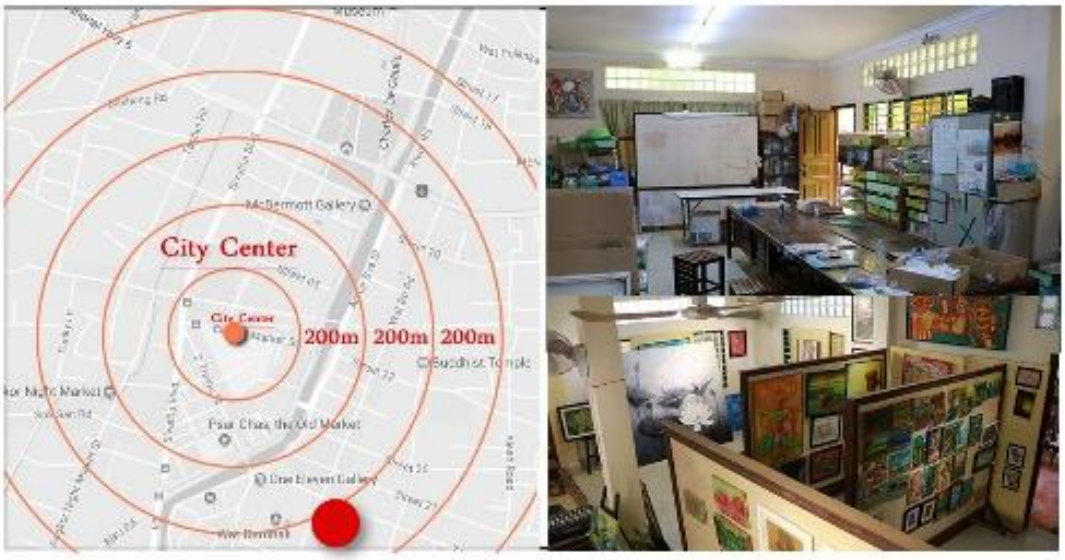


Figure 4. 9 location of Khmer Kid Art gallery from the city center (left)

Figure 4. 10 learning space on the first floor of the gallery (upper right)

Figure 4. 11 Internal space is to narrow with a lot of partition panel (lower right)

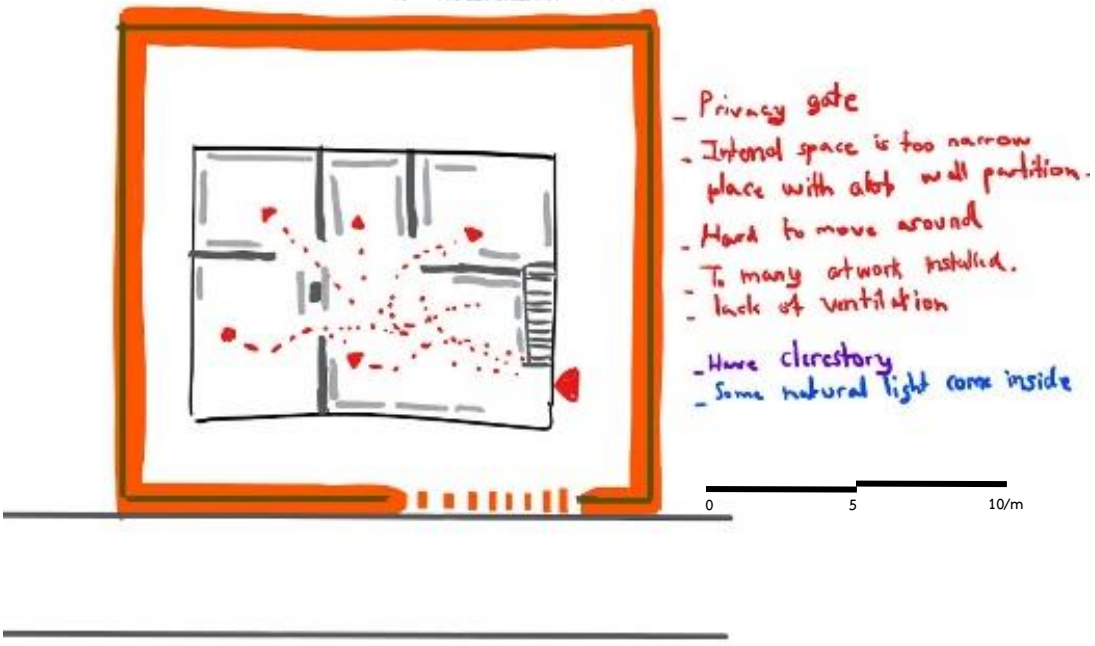


Figure 4. 12 Diagram analysis issues of the gallery building

4.3.4 Case study of McDermott Gallery art space in Siem Reap

McDermott Gallery was established by photographer John McDermott in 2004. It is situated in FCC Angkor along Pakambor Avenue in Siem Reap province, built on an 80 square meters plot situated in Cambodia's city center (Fig. 4. 13).

The facility is owned by an outlandish artist called John McDermott and is mostly utilized as a showcasing space and platform for sale of art and various merchandise. The art space receives local and foreign tourists who come to sample the unique artworks on offer. However, the facility lacks natural lighting, especially along the corridors where the artworks are displayed (Fig. 4. 14, 4. 15).

The building has installed large glass windows at the entrance, which relatively illuminates the building and allows for sufficient air circulation. It does not have any supporting structure for efficient functioning and there is a scarcity of storage facilities for tools, equipment, and artworks. The gallery is not equipped with fire protection and security systems. Nonetheless, it has a good public road network but lacks parking space for clients who may want to visit the art space in their personal vehicles. Given below is a summary analysis of the building design, as shown in the diagram.

The organization of the partitions within the gallery allows for easy movement, glass windows that ensure ventilation are only placed at the front wall, and there is insufficient natural light in the exhibition space (Fig. 4. 16).

Figure 4. 13 location of Mc Dermott gallery from the city center (left)

Figure 4. 14 View from the street toward to the gallery (upper right)

Figure 4. 15 Exhibition space of the gallery (lower right)

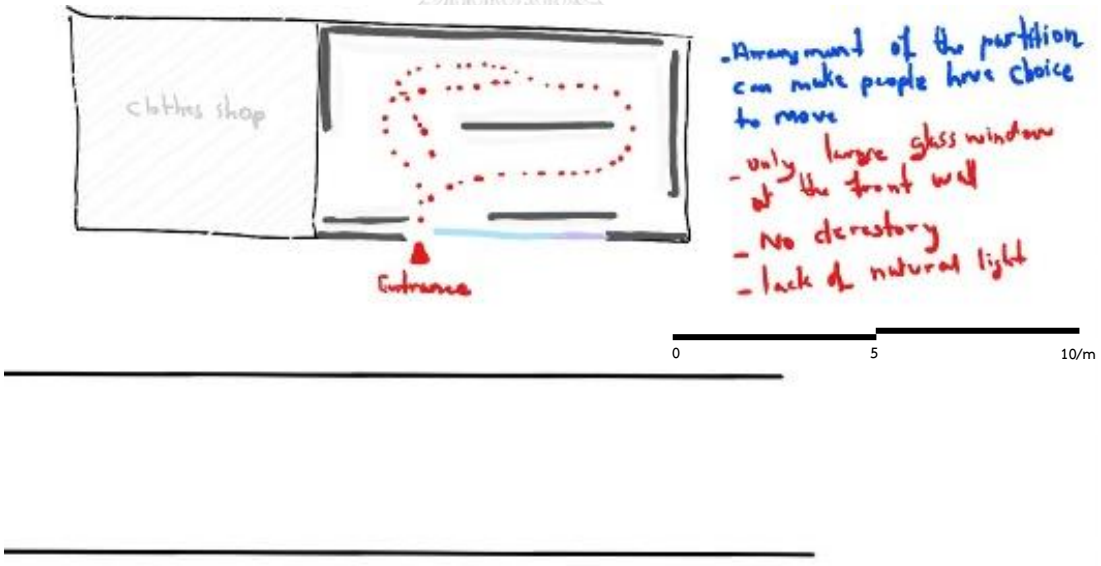


Figure 4. 16 Diagram analysis issues of the gallery building

4.3.5 Case study of Theam's House Gallery art space in Siem Reap

Theam's House Gallery was set up by artist Lim Mouyheam and constructed in 2012. The art space is situated in 25 KhumKokchak in Siem Reap province (Fig. 4. 17). The building is roughly 1500 square meters in size, providing sufficient space to navigate the gallery. The building belongs to a local artist and is utilized as a showroom, workshop, and area for selling the different artworks. Within the facility is a section that houses a private collection of artifacts for both domestic and international tourists.

It is evident that the building has a poor road network and no parking space. The entrance, however, is well-decorated and attractive for customers as shown below (Fig. 4. 18, 4. 19). There is a considerable display of attractive artworks and proper ventilation from the natural environment. An air-conditioning system has been installed to freshen the air in the sale area. There are supporting facilities such as a gallery, gift shop, and storage facilities. However, the building is lack of fire alarm and security system (Fig. 4. 20).

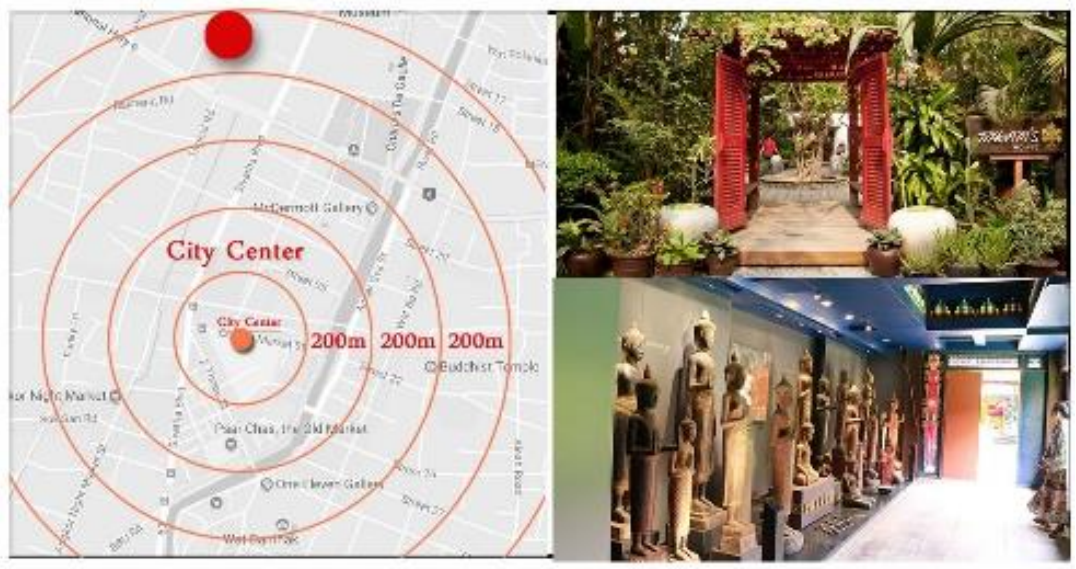


Figure 4. 17 location of Theam's gallery from the city center (left)

Figure 4. 18 Main entrance of the gallery view from the street (upper right)

Figure 4. 19 Private collection exhibition gallery (lower right)

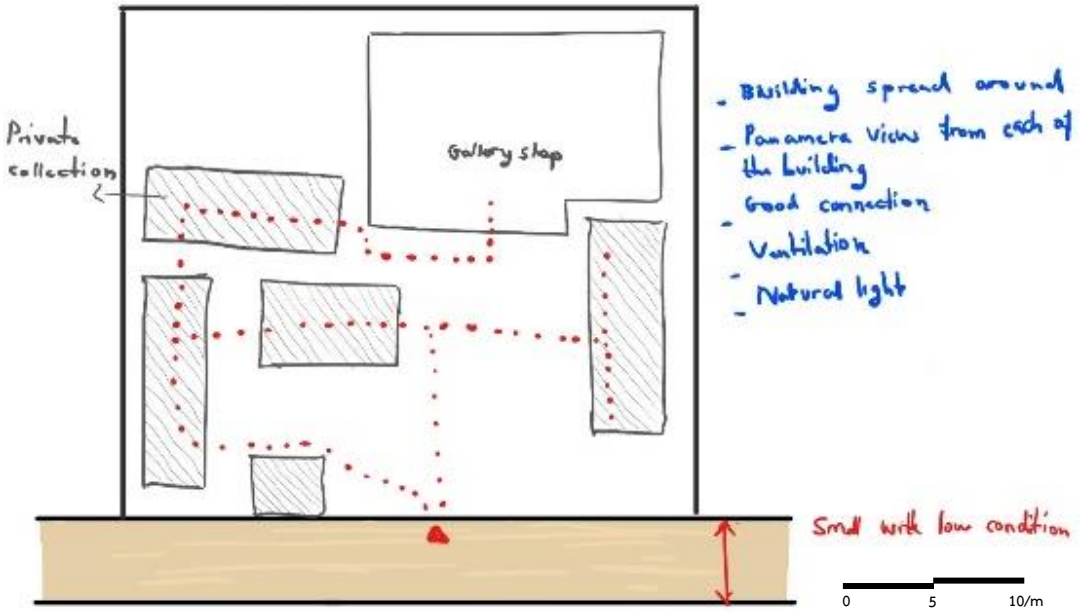


Figure 4. 20 Diagram analysis issues of the gallery building

4.3.6 Case study of Sasa Bassac art space in Phnom Penh

Sasa Bassac is found on the second floor of 18E2 along Sothearos street in Cambodia. The facility was constructed in 2011 and co-created by Erin Gleeson and Steve Selapak (Fig. 4. 21). It is located in the city center and visited by both local and international tourists. Foreign and Khmer artists use the building to showcase a variety of artworks. The gallery space is easily accessible by road, but not supplied with public transport services and lacks a parking lot (Fig. 4. 22, 4. 23).

The accessibility is unappealing because of its poor lighting and exposed environment, especially from the narrow and dark entrance. The gallery store also has no security, fire, or natural ventilation systems and movement is restricted as the building is merely 150 square meters in size. The facility has a supporting mini-library and storage space on the top floor (Fig. 4. 24).

Figure 4. 21 location of Sa Sa Bassac art space (left)

Figure 4. 22 View toward the gallery building from the main road (upper right)

Figure 4. 23 Exhibition space of the gallery (lower right)

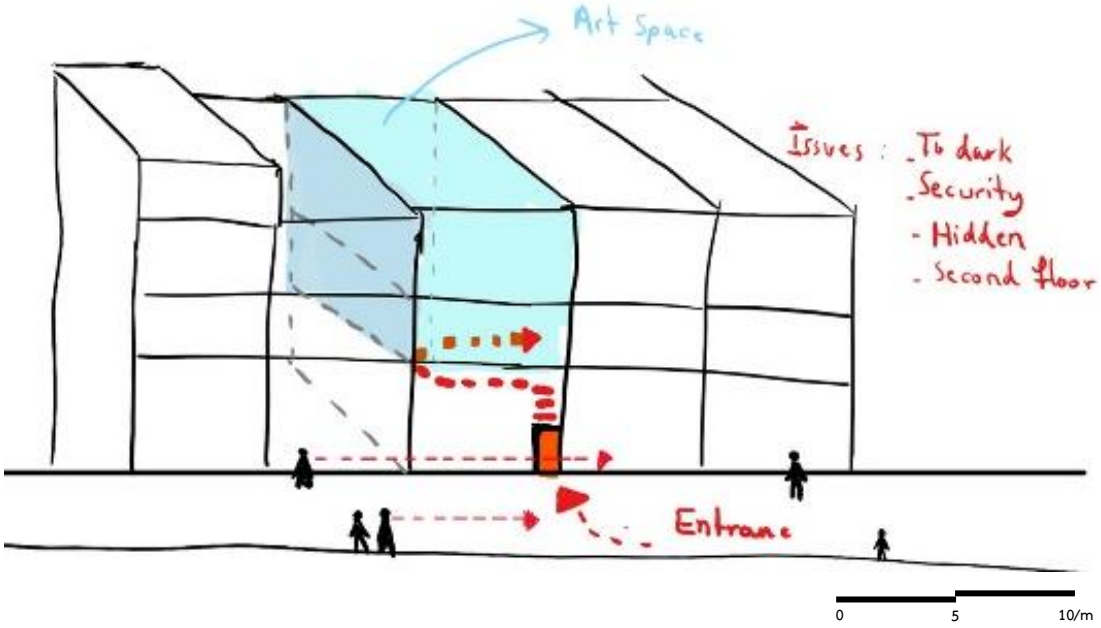


Figure 4. 24 Diagram analysis issues of the gallery building

4.3.7 Case study of X-Em Galery art space in Phnom Penh

This gallery is situated in Phnom Penh, Cambodia and was built in 2007. It was managed by a well-known designer called Em Riem who first exhibited the artworks in 2008. It is located in the city center and estimated to be 90 square meters in size (Fig. 4. 25). The building belongs to Khmer artists and is an avenue to showcase artworks by international and local artists; it also offers tours for students.

Although it is easily accessible, the gallery is unpleasant due to the limited space that restricts movement. The facility is lack of parking area (Fig. 4. 26, 4. 27). Notably, it has a calm atmosphere, supported by a skylight installed on top of the roof, facing downwards. The facility is not equipped with fire protection, security, or natural ventilation systems. It does not have any auxiliary facilities, but has sufficient storage at the side of the gallery. The utilization of natural light coming through the skylight makes the space more pleasant (Fig. 4. 28).

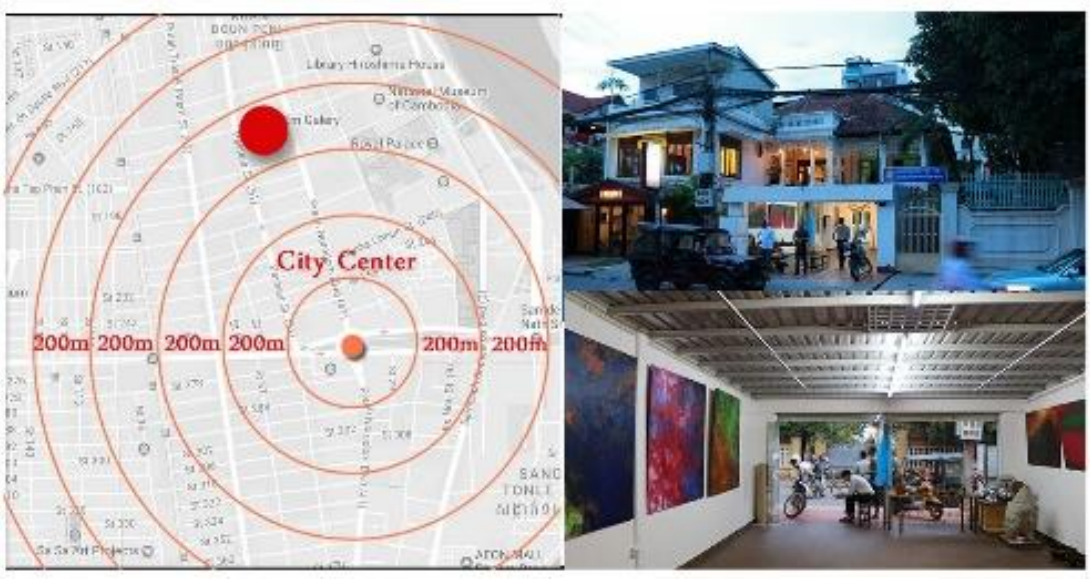


Figure 4. 25 location of X-Em Galery (left)

Figure 4. 26 View toward the gallery building from the main road (upper right)

Figure 4. 27 Exhibition space of the gallery (lower right)

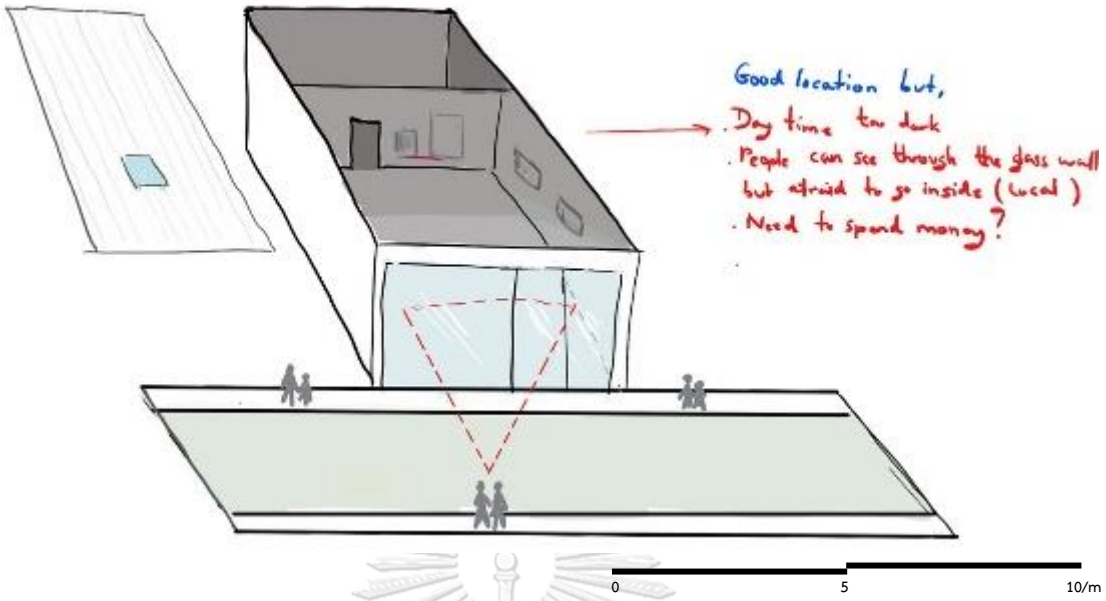


Figure 4. 28 Diagram analysis issues of the gallery building

4.3.8 Case study of Meta House art space in Phnom Penh

Meta House, built in 2007, is situated at 37 Samdach Sothearos, Phnom Penh, Cambodia (Fig. 4. 29). Nico Mesterham, a German filmmaker, and his Cambodian team founded Meta House. The building provides private institution-run spaces and conducts programs including exhibitions and semi-outdoor film screenings students (Reimer, 2013) . The exhibitors are the new generation of Khmer and foreign artists. The facility is utilized by local and overseas artists and tourists. It is accessible owing to its location in the city center but does not have a parking area (Fig. 4. 30). The complex is unattractive as an art space, since it is hard for people passing by to recognize whether there is a gallery inside. It has air-conditioning installed for a refreshing atmosphere and limited space for flexibility. It has no fire protection system, security system, or natural ventilation system. The building is approximately 300 square meters in size (Fig. 4. 31, 4. 32). Given its position as an art center, it supports different facilities, comprising a mini-cinema and restaurant on the upper floor, but offers no service as it has no proper storage; all the artworks are kept in the gallery space. Meta House, however is interested by utilizes shading devices to reduce and filter direct sunlight within the building (Fig. 4. 33).

Figure 4. 29Diagram Showing the location of Meta House art space (left)

Figure 4. 30 Photo showing the gallery building from the main road (upper right)

Figure 4. 31 Photo showing the exhibition space of the gallery (lower right)

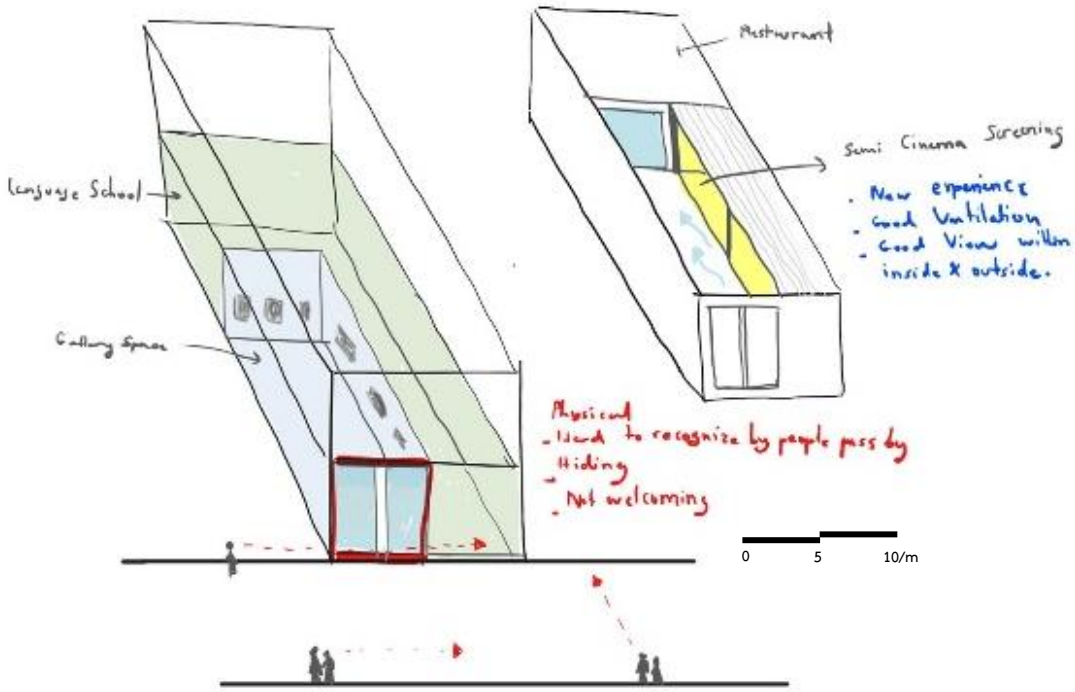


Figure 4. 32 Diagram analysis issues of the gallery building

Figure 4. 33 Meta House outdoor mini cinema and restaurant

4.3.9 Case study of SaSa Art Project art space in Phnom Penh

SaSa Art Project is located in 47, St 350, Phnom Penh, Cambodia. It was established in 2010 by Stiev Selpac and renovated in 2017 (Fig. 4. 34) The project mainly focuses on the creative and educational experience of gallery exhibition for the audience and artist. The building is used by local and foreign tourists and artists, and offers an exhibition space, artist residency, and workshop. The exhibitors include foreign artists and the new generation of Khmer artists.

Although the location is rather remote from the city center, it is in the tourist area of the genocide museum (Fig. 4. 35). It does not have natural lighting and ventilation systems, making it uninviting and unfriendly (Fig. 4. 36). It is about 50 square meters and has no fire protection and security systems in the limited space. Sasa Art Project has a clement atmosphere. It has no supporting facilities but does have proper storage behind the gallery (Fig. 4.36).

Figure 4. 34 location of SaSa Art Project art space (left)

Figure 4. 35 View toward the gallery building from the street. (upper right)

Figure 4. 36 Exhibition space of the gallery (lower right)

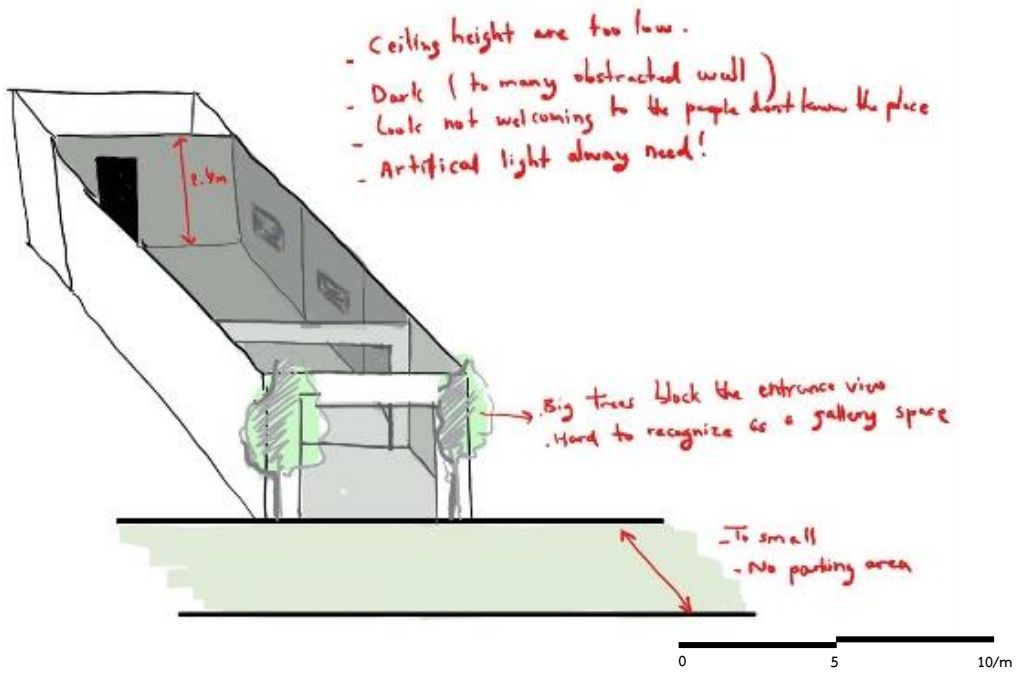


Figure 4. 37 Diagram analysis issues of the gallery building

4.3.10 Case study of Kbach Gallery art space in Phnom Penh

KBach Gallery is a new urban art gallery located in Phnom Penh. The building was refurbished in 2017 (Fig. 4. 38) as an artistic space owned by artist Tony Francis. KBach Gallery is focused on supporting as well as promoting the Cambodian street and urban art scene and artists. It is situated on Street 178 within the heart of Phnom Penh's art community. The building comprises a gallery for sale and exhibition space. The exhibitors are foreign and Khmer artists, especially those from the new generation (Fig. 4. 39). Visitors to the center include people in the art industry, local and oversea artists, and tourists. However, the institution is unattractive and its design does not distinguish it as an art hub among other adjacent shops. Furthermore, it does not have a parking area, but is itself accessible because it is located in the city center. The art gallery is roughly 20 square meters and has a shortage of natural light, as illustrated below (Fig. 4. 40). The facility has no fire protection or security system. It has no facilities or proper storage (Fig. 4. 41).

Figure 4. 38 Diagram Showing the location of Kbach Gallery (left)

Figure 4. 39 Photo showing the view from inside to the street. (upper right)

Figure 4. 40 Photo showing the exhibition space from the street (lower right)

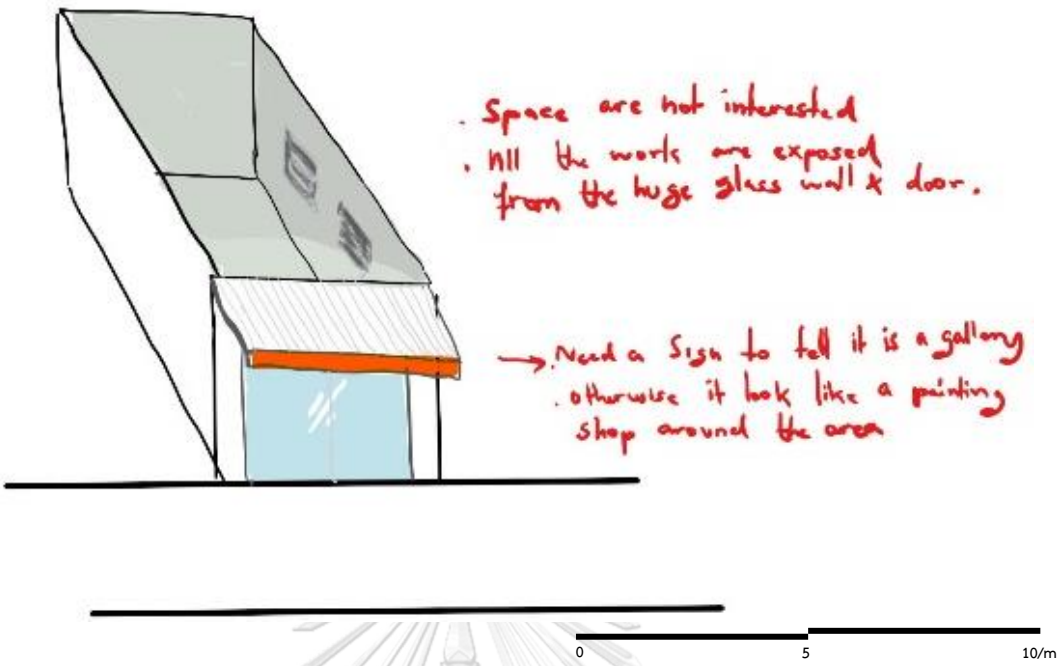


Figure 4. 41 Diagram analysis issues of the gallery building

4.3.11 Case study of Chaktomuk Conference Hall art space in Phnom Penh

Chaktomuk Theatre is situated in Preah Sisovath street, Phnom Penh and was founded by King Norodom Sihanouk in the 1960s (Fig. 4. 42). The theatre was designed by a well-known architect, Vann Molyvann, initially opened in 1961, and earmarked for redevelopment as a restaurant in 1991. It was brought back into use as a theatre in 1994, because of the destructive fire at the National Theatre. It was fully renovated in 2000, mainly to offer global-standard facilities for conferences (Ross & Collins, 2006) (Fig. 4. 43). Currently, the establishment is owned by the government and used by local and foreign tourists and artists. The exhibitors are Khmer artists. The Chaktomuk Theatre is primarily used for lectures, conferences, seminars, and, infrequently, performing arts undertakings. The location accessible because it is situated in the city center. It is attractive and desirable since it has a flexible exhibition space (Fig. 4. 44). Notably, the artistic space has a parking area. Currently, the theatre lacks a natural system for ventilation, but has natural lighting, a fire protection system, air-conditioning for a refreshing atmosphere, a security system, and a flexible exhibition space owing to the unused space under the auditorium seats. The theatre has an auditorium and

provides no service due to lack of proper storage. The theatre complex is safe and lively since the auditorium is equipped with air-conditioning and has a climate control system and a modern audio and lighting system (Fig 4. 45).

Figure 4. 42 location of Chaktomuk Conference Hall (left)

Figure 4. 43 View from Preah Sisovath street toward the conference hall. (upper right)

Figure 4. 44 Photo showing the exhibition space of the gallery on the ground floor (lower right)

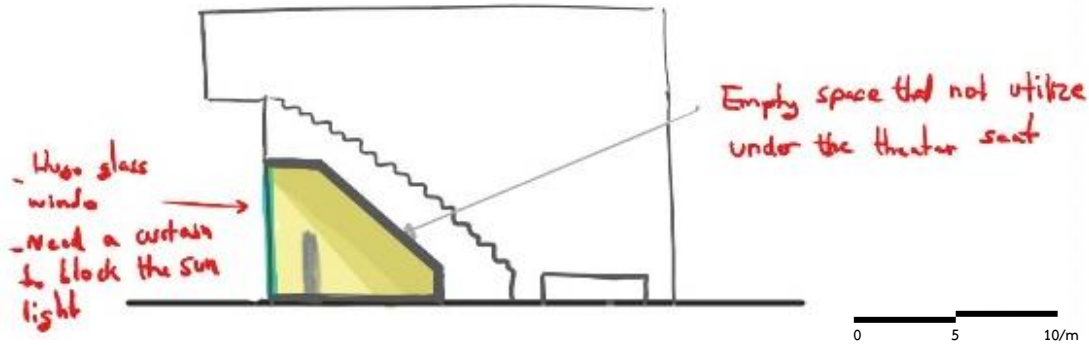


Figure 4. 45 Diagram analysis issues of the gallery building

4.3.12 Case Study of White Building Apartment in Phnom Penh

The White Building is situated to the south of the Sihanouk Boulevard, Phnom Penh, Cambodia (Fig. 4. 46). It was designed by Lu Ban Hap and Vladimir Bodiansky in 1963 and comprised 468 apartments. It was the initial effort to provide a contemporary urban style of life to the lower and middle classes in Cambodia. The building serves as a residential complex for dancers, actors, and artists. It was also included as the football field, living room, and outdoor kitchen for its residents. The artistic element in the institution is a result of the urban transformation carried out by then King Norodom Sihanouk after independence from the French. White Building was a 450 meter on the Samdach Sothearos Boulevard, close to the Bassac River. The facility was constructed as a symbol of novelty in Phnom Penh as a component of the huge composition of civic buildings (Ross & Collins, 2006). It is mainly home to businesses and shops on the ground floor, a non-profit school, art gallery, library, and street vendor in addition to hundreds of families. The residents are a mix of embattled artisans that include master musicians, classic dancers, painters, writers, and individuals skilled in crafts like embroidery (Fig. 4. 49). The artists who initially lived in the White Building ordinarily passed their room to their children or sublet their space. Then, the young new generation Cambodian artists started renting the space and built their studio so as to revitalize the building by setting up an exhibition space and community cinema program (Fig. 4. 50). The young generation artists also gathered with the locals to exchange their stories ("WHITE BUILDING ", n.d.).

Notably, the art center has an archive and a library room. The archive collects audio as well as visual materials generated by both media and art students and the White Building’s residents. Additionally, the archive gathers chosen resources from artworks jointly produced by the Cambodians and foreign artists within the neighborhood. The archive mirrors the modern experience of the vivacious community of musicians, artists, activists, and city dwellers who have lived in the facility for a long time (Fig. 4. 51, 4. 52). The location is accessible and supports public transportation with no parking areas. Although, most of the standard facilities were missing, the building is lively, given the wide range of mixed-use programs overseen within the

institution, like a combination of several villages in one structure. For example, when a resident fell sick, there was a chemist next door and a small market downstairs for cooking ingredients (Phnom Penh Post, 2017). There is no efficient security system, fire protection system, solar shading device, and temperate atmosphere. The space supports facilities comprising the community cinema and exhibition space. It is dull because it lacks natural lighting and ventilation because of several layers of additions. Furthermore, it also lacks artificial light in some area (Fig. 4. 53).

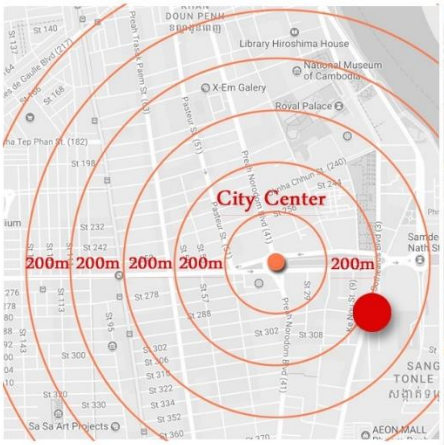


Figure 4. 46 Former location of a former White Building apartment (left)

Figure 4. 47 White building before demolished. (upper right)

Figure 4. 48 Non-profit classical dance class in the White Building apartment (right)

Figure 4. 49 Art gallery space inside the White Building apartment (left)

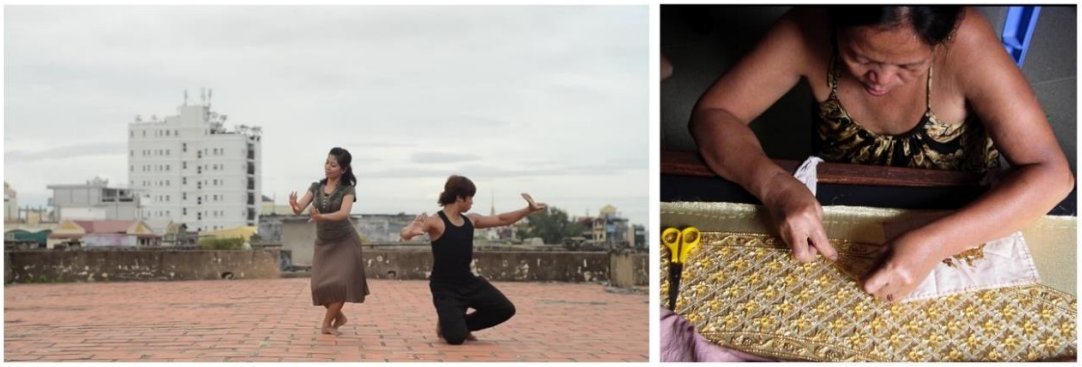


Figure 4. 50 Contemporary dance performance of the roof top of the White Building apartment (left)

Figure 4. 51 Artist doing the Khmer traditional embroidery (right)

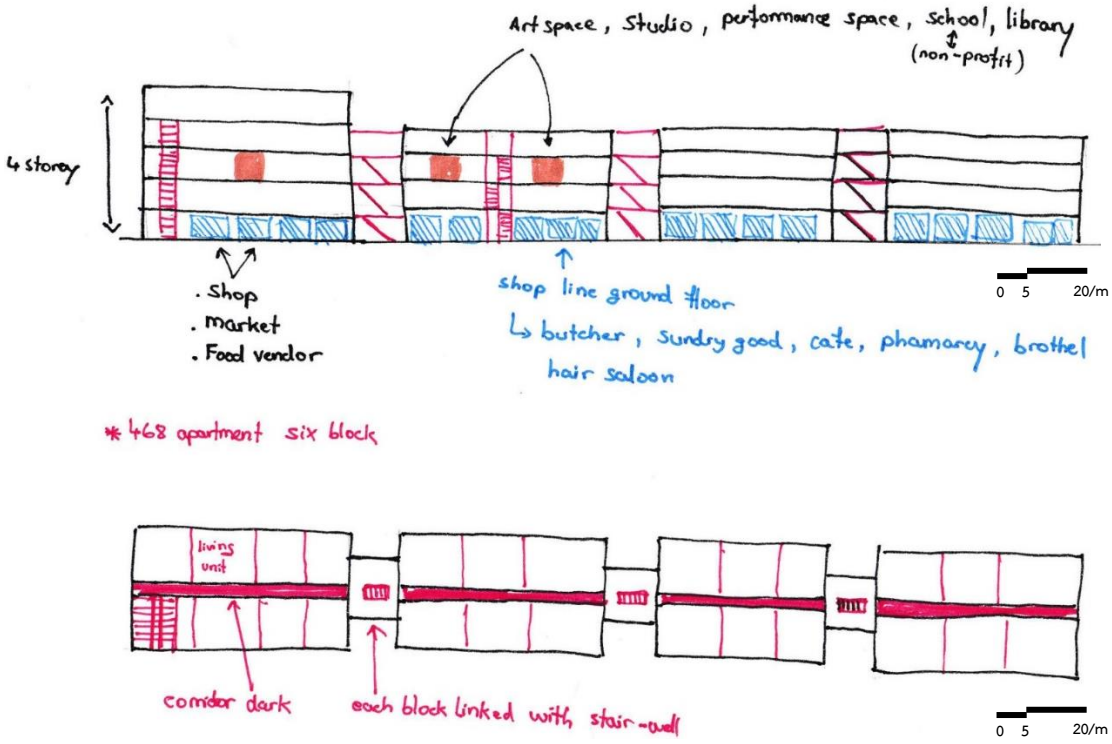


Figure 4. 52 Diagram analysis issues of the gallery building

4.3.13 Findings/Summaries

Most of the buildings adapted into contemporary art spaces in Cambodia were unattractive in terms from their accessibility, interior design and space. Generally, they lacked natural lighting and had an insecure atmosphere. In addition, they were poorly

lit, and the lighting did not reach all parts of the spaces making them mostly dark and insecure. Most of the art spaces in Cambodia are located in accessible areas, except a few, like Romachiek 5, Theam's house, and Sasa Art project. Apart from Theam's House Gallery and Chaktomuk Theater, all other facilities remain undesirable, unattractive, and insecure, with only Chaktomuk Theater having a parking area for tourists. None of the facilities support public transportation. Most of the buildings are lack of fire protection systems, with exception of Chaktomuk Theater. Only X-Em Gallery are equipped with a natural lighting device, the skylight.

4.4. Analysis of Contemporary Art Space in Thailand

4.4.1 Case study of Museum of Contemporary Art Bangkok art space in Bangkok (MOCA)

The Museum of Contemporary Art Bangkok is in Vibhavadi Rangsit, Bangkok was built in 2012. It houses the inclusive assortment of current sculpture and painting in Thailand, within its striking and purpose-constructed gallery (Fig. 4. 54). The institute was developed based on the ideas of art-loving telecommunications entrepreneur, Boonchai Bencharongkul, and the Associates Co., Limited ("History of musuem of contemporary art," 2013)(Fig. 4. 55). People in the art industry and Thai artists utilize the building as do foreign tourist and artists. Its exhibitors are mainly Thai artists. The museum has been particularly designed to offer guests the most appropriate conditions for appreciation of the exhibited art. The building has plenty of natural light as well as spaced rooms to guarantee that the art gallery is equivalent to any one overseas (Fig. 4. 56). It has an accessible location and does support public transportation. As an artistic convergence point, the institution is desirable, attractive. The museum has a fire protection system, security system, air-conditioning installed, and a permanent collection; hence, it does not require flexibility. The museum is approximately 20,000 square meters and has skylights but no natural ventilation system. It has a gallery for sale and souvenir shop, café, bookshop, and auditorium. The museum has a big storage space and is attractive since it has a skylight that provides natural light (Fig. 4. 57).

Figure 4. 53 location of MOCA art space from the city center (left)

Figure 4. 54 View toward the gallery building from the main road. (upper right)

Figure 4. 55 Ground floor exhibition space of the gallery (lower right)

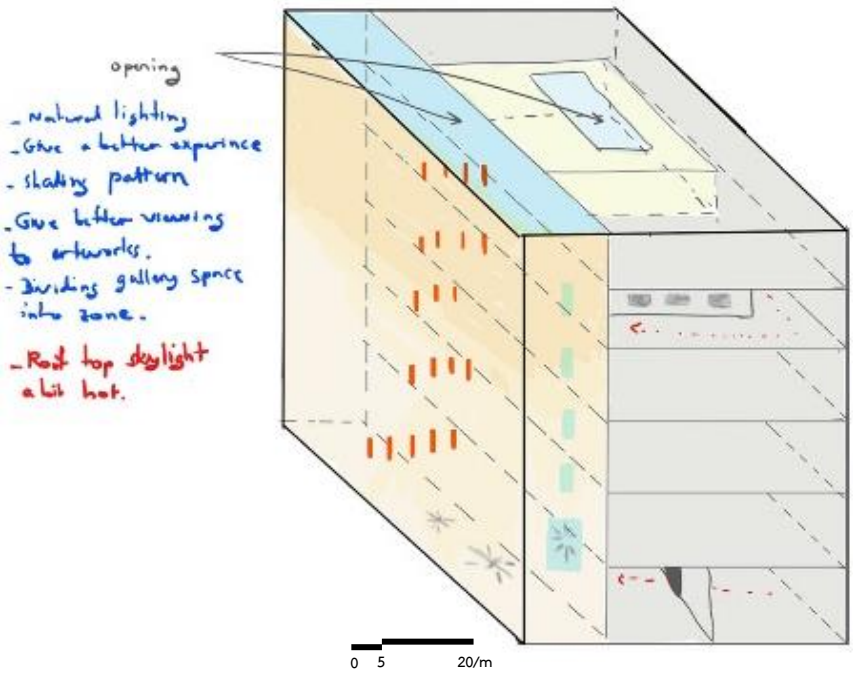


Figure 4. 56 Diagram analysis issues of the gallery building

4.4.2 Case study of Bangkok Art & Culture Center art space in Bangkok

The Bangkok Art and Culture Center is located in Pathum Wan, Bangkok and was established in 2005 and opened in 2008 (Fig. 4. 58). The idea of the building was initiated by Dr. Bhichit Rattakul in 1995 and later implemented by the city governor, known as Apirak Kosayodhin. It was designed by a renowned architect, Robert G. Bouge, in 2005. The building is administered by Bangkok Metropolitan and used by Thai artists, art students, public library users, people in the art industry, and foreign artists. The exhibitors of the building are students, Thai, and international artists. The art center is modern and centered on distinctive Thai shapes ("Bangkok Art and Culture Centre Background," 2017). It serves as the hub of the upcoming art scene in Bangkok and provides the broadest array of contemporary theatre, film, design, art, and music within the city. Moreover, it acts as a museum and has an exhibition space. It has an accessible location within the city center and supports public transportation (BTS or Sky Train system) (Fig. 4. 59). The center is desirable and attractive because it has natural lighting devices with a controlling system as well as a parking area. The establishment has a fully air-conditioned, refreshing atmosphere, security system, fire protection system and flexible exhibition space (Fig. 4. 60). However, it is roughly 5,284 square meters and has no system for natural ventilation. The building has different facilities like rental space, a library, café, bookshop, auditorium, workshop, gallery, and souvenir shop and offers service since it has storage on the second floor alongside the gallery. The Center projects relative attractiveness given the amount of financial resources committed to facilitate continuous operation (Fig. 4. 61).

Figure 4. 57 location of BACC gallery from the city center (left)

Figure 4. 58 View toward the gallery building from the National Stadium station. (upper right)

Figure 4. 59 Flexible center space, which allows the artworks to be displayed (lower right)

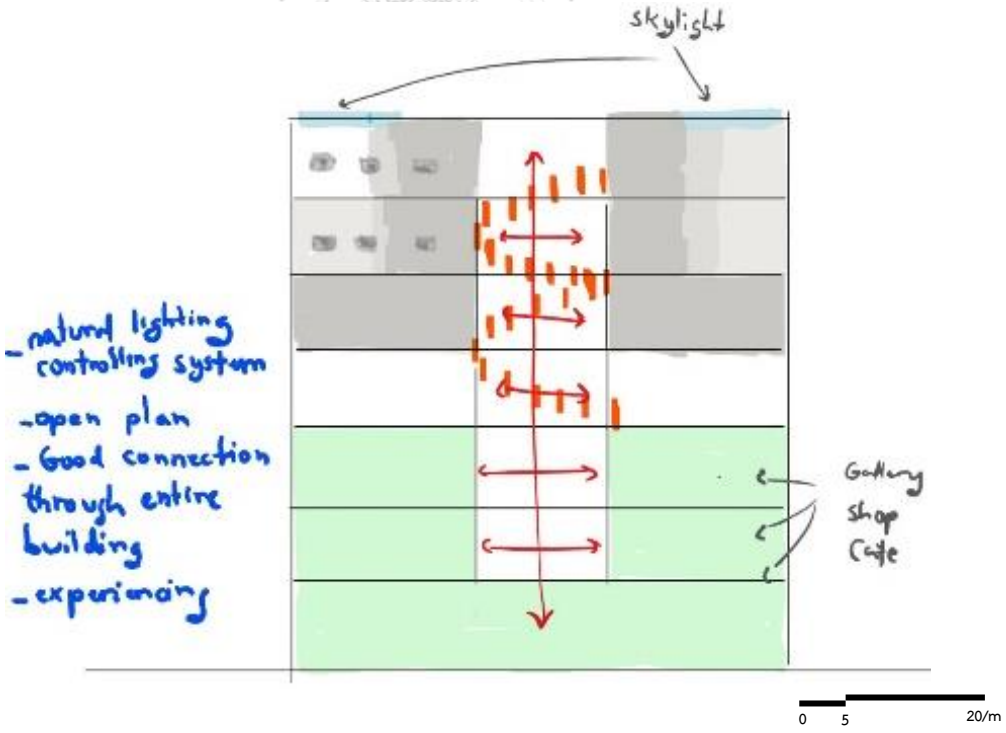


Figure 4. 60 Diagram analysis issues of the gallery building

4.4.3 Case study of Ratchadamnoen Contemporary Art Center art space (RCAC84) in Bangkok

Ratchadamnoen Contemporary Art Center is a three-storey building that hosts changing exhibitions of the mixed media modern domestic art. It is situated in Ratchadamnoen, Bangkok, Thailand (Fig. 4. 62). The building is administered by Crown Property Bureau and owned by the government ("ประวัติถนนราชดำเนิน," n.d.). Ratchadamnoen Contemporary Art Center is used by people in art industry, Thai artists, and individuals who attend the workshops. The building is in an accessible location since it is located in the city center and supports public transportation. One of the faults of the complex lies in its physical structure, which is unattractive. The building does not have a parking area. The art space has a security system, fire protection system, air-conditioned refreshing atmosphere, and flexible exhibition space (Fig. 4. 63) (Fig. 4. 64). It is approximately 5000 square meters and supports facilities comprising an auditorium and workshop as well as storage on the ground floor behind an exhibition space. It has abundant natural light and its exhibition rooms have a black wood roof structure, which generates an ideal contrast with an exterior view of the sky, recognizable through the sunroof on the third floor exhibition space. Moreover, the building has no shading apparatuses that reduce and filter direct sunlight into the building on the ground and second floors and the flexible space is limited because of the existing structure (Fig. 4. 65).

Figure 4. 61 location of RCAC84 art space form the city center (left)

Figure 4. 62 Temporary exhibition on the ground floor (upper right)

Figure 4. 63 Abandon space without controlling overall circulation (lower right)

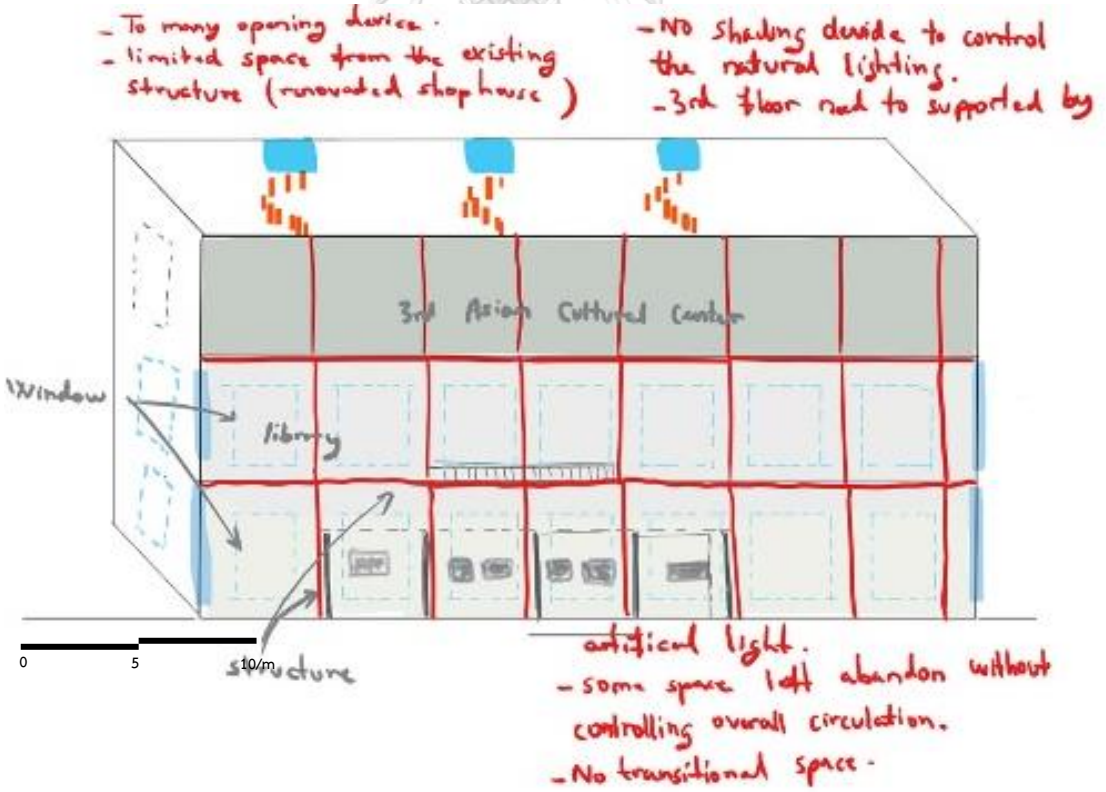


Figure 4. 64 Diagram analysis issues of the gallery building

4.4.4 Case study of Bangkok CITYCITY Gallery art space in Bangkok

Bangkok CityCity Gallery was founded by the former Thailand creative and design center curator, Supamas Phahulo and art collector and filmmaker Akapol ‘Op’ Sudasna in 2015. It is located in Sathorn, Bangkok (Fig. 4. 66). It was designed by Chutayaves Sinthuphan to create a space of simplicity and nature ("Bangkok CityCity Gallery/Site-Specific ", 2016) (Fig. 4. 67). Its visitors include Thai and foreign artists and individuals in art industry; its exhibitors are Thai and overseas artists. Its location is accessible and is close to public transportation, within walking distance of the MRT station (underground railway). The gallery is attractive since it has natural and artificial lighting devices with a controlling system. The art center has a parking area. The building has a security system, refreshing atmosphere, fire protection system, and flexible exhibition space (Fig. 4. 68). It has no natural ventilation system and is about 374 square meters in size. The building has distinct facilities, including a gallery and souvenir shop and café. It can provide service due to the storage at the back attached to the main gallery building. The arcade is manageable owing to its upper lighting device, the skylight, which provides natural light and minimizes the quantity of electricity use from the artificial light. The building provides a financially viable option because natural light is permitted to enter the gallery from the top through skylights, from the bottom through linear openings at floor-level, and from the side next to the entrance (Fig. 4. 69).

Figure 4. 65 location of Bangkok City City gallery (left)

Figure 4. 66 View toward the gallery building from the street. (upper right)

Figure 4. 67 Main exhibition space of the gallery (lower right)

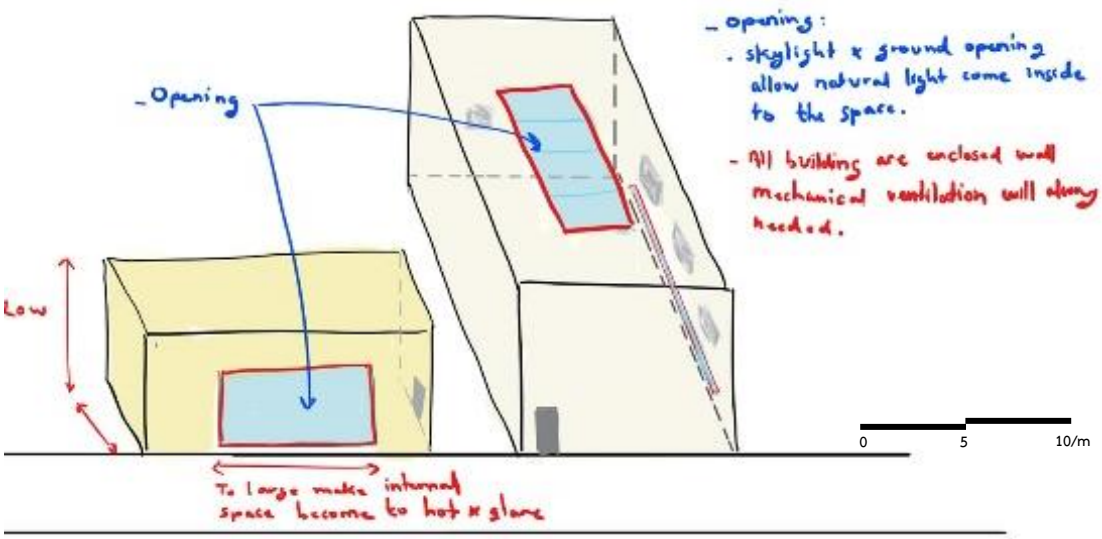


Figure 4. 68 Diagram analysis issues of the gallery building

4.4.5 Case study of MAIIAM Contemporary Art Museum art space in Chiang Mai

MAIIAM Contemporary Art Museum was founded by the Bunnag-Beurdeley family and completed in 2015. The private museum is located in Amphoe San Kamphaeng, Chiangmai and is approximately 3000 square meters (MAIIAM, n.d.) (Fig. 4. 70). The facility is used as an exhibition space, museum, gallery for sale, café, and restaurant. The space is accessed by both local and foreign tourists, artists, art students, and people in the art industry. It is fully developed, with an attractive well-decorated building design (Fig. 4. 71). The building has natural lighting, a permanent collection gallery, and flexible exhibition space (Fig. 4. 72). It gives viewers a better experience and has transitional space and interconnections, even though it does not have access to public transportation, but supports with a parking area. The facility has a fire protection system, security system, and skylight with controlling system and a refreshing atmosphere. The museum is structured to facilitate the entry of light. Natural light is provided through innovative architectural solutions, including skylights and light wells (Fig. 4. 73)

Figure 4. 69 Diagram Showing the location of MAIIAM musuem (left)

Figure 4. 70 View toward the museum from the street. (upper right)

Figure 4. 71 Main exhibition space of the gallery (lower right)

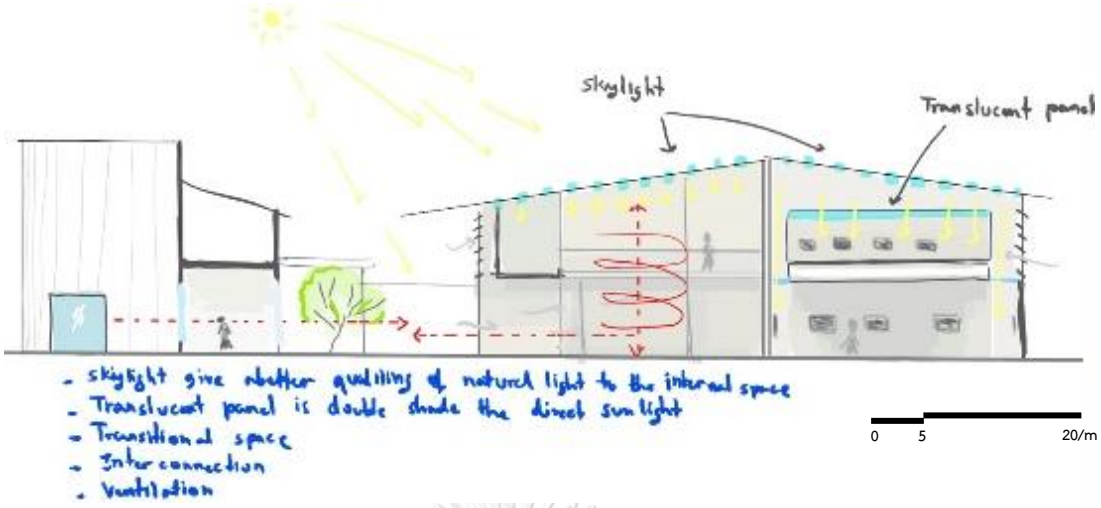


Figure 4. 72 Diagram analysis issues of the gallery building

4.4.6 Case study of Jim Thompson House & Museum art space in Bangkok

The Jim Thompson House & Museum it is owned by Jim Thompson foundation. The building is located in Kasemson Road, Bangkok (Fig. 4. 74). Occupies approximately 230 square meters, giving limited space for flexibility. The art space is usually accessed by foreign tourists, artists, people in the art industry, and people who attend the workshops ("THE JIM THOMPSON ART CENTER," n.d.) (Fig. 4. 75). The gallery was designed with Thai traditional architecture style, which cannot easily recognize whether there is a gallery on the upper floor or just a traditional home. The house has too many opening devices from the traditional style architecture. However, gallery is desirable, interior space are well decorated with flexible space for art work installation and equipped with air-conditioning system. Despite that, the space is lack of proper storage and natural lighting. Artificial light is needed to support the space lighting system (Fig. 4. 76). The museum had access to public transportation such as Khlong Saen Sap Boat and is within walking distance of the BTS National Stadium, but does not have parking areas. The facility has a security system, refreshing atmosphere, and the side windows are operable; one is able to move freely. (Fig. 4. 77)

Figure 4. 73 location of JIM THOMSOM art space (left)

Figure 4. 74 View toward the museum from the street. (upper right)

Figure 4. 75 Main exhibition space of the gallery on the 1st floor (lower right)

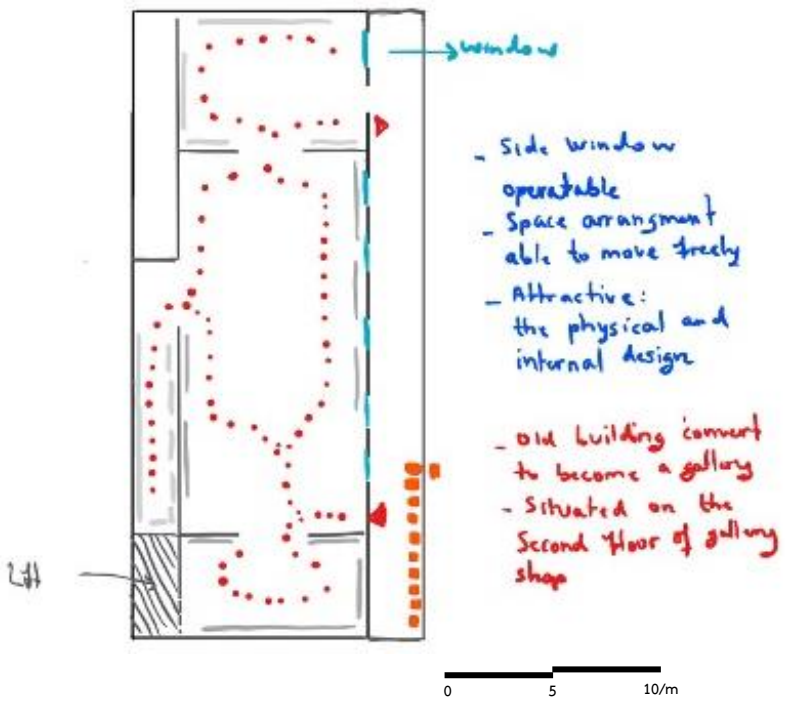


Figure 4. 76 Diagram analysis issues of the gallery building

4.4.7 Case study of Art Center Silapakorn University art space in Bangkok

Art Center Silapakorn University is located in Bangkok (Fig. 4. 78). It was transformed into a gallery by artist Corrado Feroci. The facility is owned by the government and used as an exhibition space and workshop ("History of Silapakorn University," n.d.). It is used by foreign tourists, artists, people in art industry, and students. The building occupies a functional space of about 850 square meters and is accessible because it is positioned in the city center with supports parking areas (Fig. 4. 79). Since it was a renovated building the original structure has too many opening devices and It has limited space for flexibility (Fig. 4. 80). The space lacks a fire protection system, solar shading devices, natural ventilation, security system, supporting facilities, and proper storage. It has an efficient lighting system and shading devices backed by artificial lights. The shading devices assist in reducing and filtering direct sunlight in the building. Although located in Thailand, the facility has not improved and lags behind as compared to other art spaces in Thailand (Fig. 4.81).

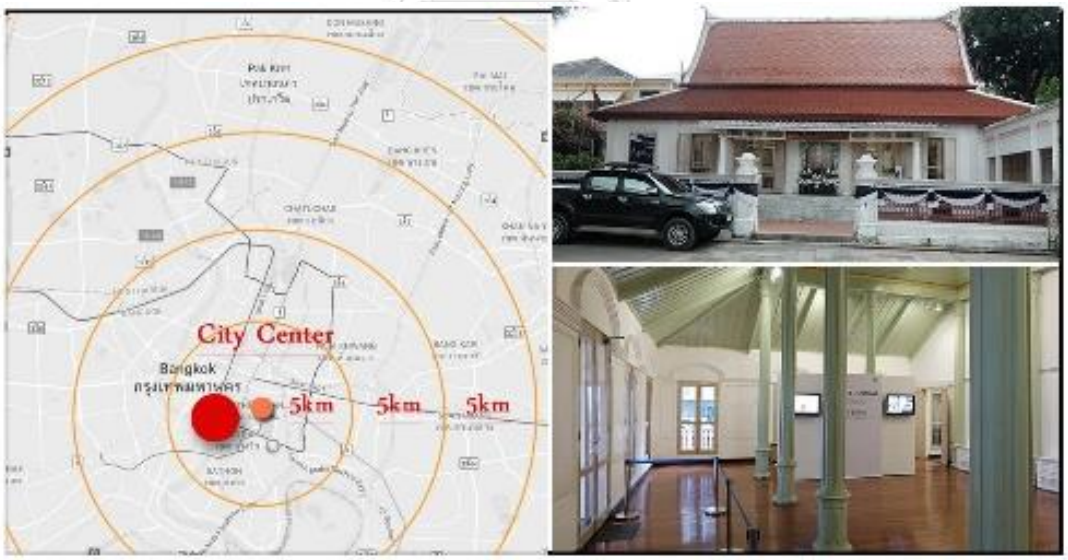


Figure 4. 77 location of Silapakorn University art space (left)

Figure 4. 78 View toward the gallery from the street. (upper right)

Figure 4. 79 Main exhibition space of the front gallery on the 1st floor (lower right)

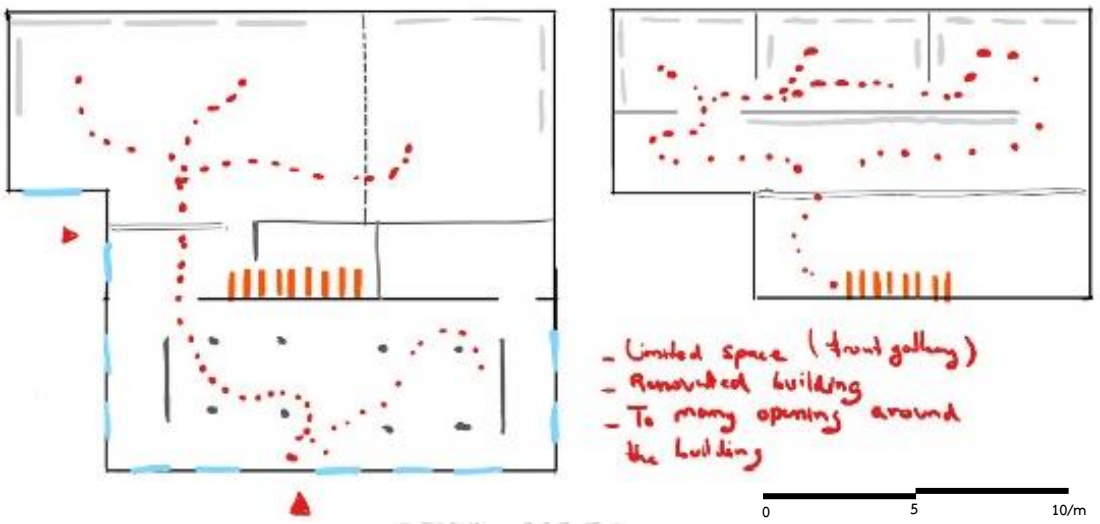


Figure 4. 80 Diagram analysis issues of the gallery building of the ground floor (left) and second floor (right).

4.4.8 Findings/Summaries

Most of the art spaces in Thailand are accessible, with supporting public roads, sufficient parking spaces, and fire protection systems, with the exception of a few, like Art Center Silapakorn University. The art spaces have flexible exhibition space and security systems. All buildings have an air-conditioned, refreshing atmosphere, most have supporting facilities, storage devices, and are sustainable because of artificial and natural lighting systems. The art spaces are owned by the government, locals, and even foreign investors. Most of the buildings are fully developed with attractive designs. Nonetheless, there are some art spaces that lack basic facilities to date. Such buildings include Art Center Silapakorn University which does not have access to a public road, parking space, or security system.

4.5 Comparison from the 2 Findings Art Space in Cambodia and Thailand

Most contemporary art spaces in Cambodia do not support public transportation and parking space as compared to Thailand, which has sufficient parking space and mostly good accessible roads. Moreover, the art space in Cambodia lacks control in terms of fire protection and security systems and most are not flexible as

exhibition space, unlike in Thailand where almost all of the buildings are accessible and have art space control systems. The majority of art spaces in Cambodia are not sustainable because they either lack natural lighting and ventilation or artificial lighting to support the structure; in Thailand, the buildings are well-lit and ventilated due to sufficient lighting systems. The buildings in Cambodia were not designed and built as art space from the beginning. Therefore, the transformations were limited due to the physicality of the buildings and fundings. It is also worth noting that art spaces in Thailand have a refreshing, air-conditioned atmosphere that attracts most tourists. Most of the artifacts in Cambodia cover very small functional areas and, consequently, have limited space for flexible exhibitions as compared to those in Thailand, which cover large areas and have room for flexible exhibitions (Table 1. 2).

Table 1. 2 Analysis comparison of contemporary art space in Cambodia and Thailand

Table Analysis Art Space Case Studies in Cambodia and Thailand					
Case Study	**Approach/ Accessibility**	**Art Space (Control)**	**Supporting Facility**	**Service**	**Others**
Romcheik 5 Location: Battambang, Cambodia. Built: 2012	• Inaccessible location. • No public transportation supported. • No supporting parking area. • Undesirable. • Unattractive. • Insecurity atmosphere.	• No fire protection system. • No solar shading devices. • Warm temperature • Vent provide natural ventilation • No security system • Size: approx. 240 sq.m. • Limited space for flexibility.	• No supporting facilities.	• No proper storage (all artworks are keep in the gallery space).	• Natural light for art space is achieved through glass block clerestory (side lighting). • Vent which the local material element that provide the ventilation

					inside the building.
Sangker Location: Battambang, Cambodia. Renovated: 2011	• Accessible location. • No public transportation supported. • No supporting parking area. • Undesirable. • Unattractive.	• No fire protection system. • Lack of natural-lighting. • Warm temperature • No natural ventilation system. • No security system. • Size: approx. 104 sq.m. • Limited space for flexibility	• Gallery and souvenir shop.	• No proper storage (all artworks are keep in the gallery space).	• Beyond the 2 window at the backside of the gallery which cannot provide enough lighting for the space, top lighting should be a suitable devices to use.
Khmer Kid Art Gallery Location: Siem Reap, Cambodia. Built: 2015	• Accessible location. • No public transportation supported. • No supporting parking area. • Undesirable. • Unattractive.	• No fire protection system. • Lack of natural-lighting control. • Warm temperature • No natural ventilation system. • No security system. • Size: approx. 192 sq.m. • Limited space for flexibility	• No supporting facilities.	• No proper storage (all artworks are keep in the gallery space).	•
McDermott Gallery	• Accessible location (situated in the city center).	• No fire protection system. • Lack of natural-lighting.	• No supporting facilities.	• No proper storage (all artworks are keep	• Top and side lighting device help to reduce

Location: Siem Reap, Cambodia. Built: 2004	• No public transportation supported. • No supporting parking area. • Unattractive.	• Refreshing atmosphere (A/C). • No natural ventilation system. • No security system. • Size: approx. 80 sq.m. • Limited space for flexibility.		in the gallery space).	the amount of electricity consumption from use of artificial light.
Theam's House Gallery Location: Siem Reap, Cambodia. Built: 2012	• Inaccessible location. • No public transportation supported. • No supporting parking area. • Desirable. • Attractive.	• No fire protection system. • No Solar shading devices. • Warm temperature. • Natural ventilation. • No security system • Size: approx. 1500 sq.m. • Flexibility exhibition space.	• Gallery and souvenir shop.	• Permanent collection exhibited along the dispersed gallery. • Storage located at the back side of the gallery and souvenir shop.	•
Sasa Bassac Location: Phnom Penh, Cambodia. Built: 2011	• Accessible location (situated in the city center). • No public transportation supported. • No supporting parking area. • Undesirable. • Unattractive.	• No fire protection system. • Lack of natural-lighting. • Refreshing atmosphere (A/C). • No natural ventilation system. • No security system. • Size: approx. 150 sq.m.	• Mini Library.	• Storage placed on the top floor of the gallery.	•

	• Insecurity atmosphere.	• Limited space for flexibility.			
X-Em Galery Location: Phnom Penh, Cambodia. Built: 2007	• Accessible location (situated in the city center). • No public transportation supported. • No supporting parking area. • Unattractive.	• No fire protection system. • Natural lighting device (skylight). • Warm temperature. • No natural ventilation. • No security system. • Size: approx. 90sq.m. • Limited space for flexibility.	• No supporting facilities.	• Storage placed on the side of the gallery.	•
Meta House Location: Phnom Penh, Cambodia. Built: 2007	• Accessible location (situated in the city center). • No public transportation supported. • No supporting parking area. • Unattractive. • Undesirable.	• No fire protection system. • Lack of natural-lighting. • Refreshing atmosphere (A/C). • No natural ventilation system. • No security system. • Size: approx. 300 sq.m. • Limited space for flexibility.	• Restaurant • Mini cinema (Second floor).	• No proper storage (all artworks are keep in the gallery space).	•

Sasa Art Prjoect Location: Phnom Penh, Cambodia. Renovated: 2017 (New location)	• Inaccessible location. • No public transportation supported. • No supporting parking area. • Unattractive. • Undesirable.	• No fire protection system. • Lack of natural-lighting. • Warm temperature • No natural ventilation system. • No security system. • Size: approx. 50 sq.m. • Limited space for flexibility	• No supporting facilities.	• Storage placed at the backside of the gallery.	•
Kbach Gallery Location: Phnom Penh, Cambodia. Renovated: 2017	• Accessible location (situated in the city center). • No public transportation supported. • No supporting parking area. • Unattractive.	• No fire protection system. • Lack of natural-lighting. • Refreshing atmosphere (A/C). • No natural ventilation system. • No security system. • Size: approx. 48 sq.m. • Limited space for flexibility.	• No supporting facilities.	• No proper storage (all artworks are keep in the gallery space).	•

Chaktomok Theater Location: Phnom Penh, Cambodia. Built: 1961	• Accessible location (situated in the city center). • No public transportation supported. • Supporting parking area. • Desirable. • Attractive.	• Fire protection system. • Lack of natural-lighting (Conference hall). • Refreshing atmosphere (A/C). • No natural ventilation system. • Security system. • Size: approx. sq.m. • Flexibility exhibition space. (the un-utilized space under the auditorium seats)	• Auditorium		•
White Building Apartment Location: Phnom Penh Cambodia. Built: 1963	• Accessible location (situated in the city center). • Unattractive. • Undesirable.	• No fire protection system. • Lack of natural-lighting. • No security system. • Limited space for flexibility.	• Café shop. • Grocery shop (ground floor).	• No proper storage (all artworks are keep in the gallery space).	•

Museum of Contempor --ary Art Bangkok (MOCA) Location: Bangkok, Thailand. Built: 2012	• Accessible location. • No public transportation supported. • Supporting parking area. • Desirable. • Attractive.	• Fire protection system. • Natural lighting device (skylight). • Refreshing atmosphere (A/C). • No natural ventilation system. • Security system. • Size: approx. 20,000 sq.m. • Permanent collection (Don't need flexibility).	• Café shop. • Gallery and souvenir shop. • Book Shop. • Auditorium		•
Bangkok Art & Culture Center (BACC) Location: Bangkok, Thailand. Built: 2008	• Accessible location (situated in the city center). • Supporting public transportation (Bts sky -strain). • Supporting parking area. • Desirable. • Attractive.	• Fire protection system. • Natural lighting device (skylight) with controlling system. • Refreshing atmosphere (A/C). • No natural ventilation system. • Security system. • Size: approx. 5,284 sq.m. • Flexibility exhibition space.	• Café shop. • Gallery and souvenir shop. • Book Shop. • Auditorium • Workshop. • Library. • Rental space.	• Storage placed on the second floor beside the people gallery.	•

Ratchadam -noen Contempor ary Art Center (RCAC) Location: Bangkok, Thailand. Renovated: 2012	• Accessible location (situated in the city center). • Supporting public transportation (Brt). • No supporting parking area. • Unattractive. • Undesirable.	• Fire protection system. • No Solar shading devices. • Refreshing atmosphere (A/C). • No natural ventilation system. • Security system. • Size: approx. 5,000 sq.m. • Flexibility exhibition space. (Due to the existing structure made the space limit).	• Auditorium • Workshop.	• Storage placed on ground floor at the backside of the exhibitio n space.	• Using shading devices help to reduce and filter the direct sun light inside the building.
Bangkok CITYCITY Gallery Location: Bangkok, Thailand. Built: 2015	• Accessible location. • No public transportation supported. • Supporting parking area. • Desirable.	• Fire protection system. • Natural lighting device (skylight) with controlling system. • Refreshing atmosphere (A/C). • No natural ventilation system. • Security system. • Size: approx. 374 sq.m. • Flexibility exhibition space.	• Café shop. • Gallery and souvenir shop.	• Storage placed at the back side attached to the gallery.	• Top lighting device (skylight) help to reduce the amount of electricity consumptio n from use of artificial light.
MIIAM Contempor	• Accessible location.	• Fire protection system.	• Café shop. • Restaurant.		• Natural light for art

ary Art Museum Location: Chiang Mai, Thailand. Built: 2015	• No public transportation supported. • Supporting parking area. • Desirable. • Attractive.	• Natural lighting device (skylight) with controlling system. • Refreshing atmosphere (A/C). • Natural ventilation system. • Security system. • Size: approx. 3,000 sq.m. • Flexibility exhibition space and permanent collection gallery.	• Gallery and souvenir shop.		space is achieved through light wells. • Double layer of transparency ceiling material served as the light filter which gave a better quality of light and also reduced the heat in the gallery space.
Jim Thompson House & Museum Location: Bangkok, Thailand. Built: 2012	• Accessible location (situated in the city center). • Supporting public transportation (Bts). • No supporting parking area. • Unattractive (art gallery building). • Undesirable (art gallery building).	• Fire protection system. • Lack of natural-lighting. • Refreshing atmosphere (A/C). • No natural ventilation system. • Security system. • Size: approx. 230 sq.m. • Limited space for flexibility.	• Café shop. • Restaurant. • Gallery and souvenir shop.	• No proper storage (all artworks are keep in the gallery space).	•

Art Center Silapakorn University Location: Bangkok, Thailand. Built: 1979	• Accessible location (situated in the city center). • No public transportation supported. • No supporting parking area. • Unattractive. • Undesirable.	• No fire protection system. • No Solar shading devices. • Refreshing atmosphere (A/C). • No natural ventilation. • No security system. • Size: approx. 850 sq.m. • Limited space for flexibility (Due to the existing structure made the space limit).	• No supporting facilities.	• No proper storage (all artworks are keep in the gallery space).	• Using shading devices help to reduce and filter the direct sun light inside the building.

4.6 Conclusion

Arts play an essential role in assisting Cambodians in getting their cultural heritage back and being equipped for the imminent resurgence. Most of the art spaces in Cambodia have not been equipped well enough renovated and lack most of the control system, making them insecure, and unappropriated for users. Contemporary art spaces in Cambodia need radical improvement. Some key areas that should be considered from general design, decoration, art space control, supporting facilities aspects. The art space should be well equipped with standard facilities, while embraces sustainable design approaches.

CHAPTER 5 DESIGN PROCESS

5.1 Background of the Project

The design part of the thesis seeks to create an art space in Phnom Penh. Presently, the available art spaces are rather small, private-run, and mainly used for cultural and educational purposes. These art spaces often lack sufficient funding, since they rely mainly on cultural activities and very little on commercial ones. The basic bills and utilities have often proven to be very difficult to pay, not only on account of the lack of commercial support but also because of the high energy consumption.

Many case studies were conducted in Cambodia to find out the state of the buildings as well as the condition of the art spaces that are still operational (Chapter 4). It was discovered that most of the buildings have a very poor design, to the extent that they fail to attract even Cambodian citizens. The interior of these places was observed to be rather unattractive. Additionally, it was evident that some of them were unable to afford the provision of quality lighting at any given moment of time, thus leaving them very dark and insecure appearance. They also located in inaccessible areas, although the audiences may possess the desire and interest in culture and art, the transport infrastructure would make it extremely difficult for them to gain access to the spaces.

In some other cases, the art spaces are not friendly because of the design; some have poor ventilation that fails to suffice for a large crowd. Well-equipped art spaces would bring people from different cultures together, thereby finally creating art awareness for the general public. Most of the citizens in Cambodia are not aware of the existence of contemporary art or of the difficulties involved in accessing the art spaces. Thus, they find it hard to showcase their culture and artworks to the general public.

To further promote contemporary art activities in the country, the thesis proposes a bigger space for contemporary art that would be capable of providing a more sustainable design approach to reduce energy consumption and, thereby, the running cost. Moreover, some art-related commercial activities would be added to the

programs as a source of extra funds as well as an attraction to that section of the audience that is not very familiar with contemporary art. In doing so, the project will help to ensure collaboration for the propagation of culture across the generations to come.

5.2 Users and Programme

From the case studies of both art spaces in Cambodia and Thailand the project proposes to include the programs that could house different kinds of art related activities, for different types of users. Also, commercial areas are crucial to support none-profit activities.

Main Gallery: This will be located on the upper part of the building, with several flexible exhibition gallery spaces available for rent, from the smallest to the largest space in terms of area. More formal art exhibitions will be housed in the galleries. It will serve as the backbone of the art industry for the building.

Café/Restaurant: These are the main supporting facilities that will play a central role towards facilitating meetings and interactions between people. Visitors will also get a chance to relish various dishes associated with the Cambodian culture, which is highly valued by the community. Traditional drinks will also be served, so that visitors can have a taste of the beverages, soft, and alcoholic drinks appreciated by the natives. Since the restaurant is located in the art space for the propagation of artwork and culture, art will be showcased in the different food and drinks displays. There will be paintings and sculptures on the walls related to food and drinks.

Studio/Meeting/Lecture: This space will mainly be meant for students or artists who want the space to work, study, or conduct meetings or events. The room is flexibly equipped for any event; even different organizations and the public at large are welcome to book the room and use it for their purpose for the intended period.

Arts Class: Free classes of art, including painting, classical and contemporary dance, traditional and contemporary music, sculpture, and the like will be organized for students, especially children, youth, or people who do not have enough money to pay for school. This gesture will also encourage and help the propagation of art and culture. These classes will be conducted on a daily basis for anyone, irrespective of their citizenship. The aim of these classes will be to strengthen relationships with other stakeholders and nations where culture and art are concerned.

Library: Art and culture books will be stored here, and users of the art space will be given the opportunity to study more in-depth. Similarly, there will be a display in the library, whereby people will be encouraged to freely read and acquire knowledge about arts and some other subjects related to the culture of Cambodia. References will be made of books to be bought in the bookstore.

Shop/Retail Space (Souvenir): This will serve as a rental space for the artists to display and sell their artworks. They will be able to conduct their own individual exhibitions at their convenience, but all activities in the shop should purely be concerned with culture and art.

Bookshop: The main function of the bookshop will be selling books and articles related to the culture of Cambodia. Also, any attractive artwork that may have won contests or other honors will be made available in the bookshop for people to buy in order to support the artist. After touring the art space, one will be able to buy a book to inform themselves about the cultural practices that attract them the most.

Art Gallery Shop: This will be located on the ground floor near the main entrance next to the exhibition gallery. Selling artworks and souvenirs, this will serve as a place for visitors to buy what interests them. This shop will be owned by the gallery building, as it will also serve as a marketing opportunity for artists to publicize and sell their paintings, sculptures, and other artworks.

Archive Room: Located on the exhibition floor, this room will be used to store documents and books pertaining to artworks. All artwork exhibited in the gallery will be stored here for reference purposes by the artists, who are expected to help perfect their works of art. Similarly, old books from the library will be stored here to make more space available for new books and art materials.

Program					
Supporting Facilities	Function	User	Quantity	Area	Fl
	Information	4	1	10 sq.m	G
	Atrium	300	1	600 sq.m	1
	Tiecket Area	4	1	10 sq.m	3
	Shops (Souvenir)		5	200 sq.m	G,1
	Café + Resturants		14	1300 sq.m	G,1
	Book Shop		1	250 sq.m	1
	Art Gallery Shop		1	133 sq.m	G
	Art Class		4	150 sq.m	1,2
	Mini Library		1	85 sq.m	2
	Studio/ Meeting Room		6	380 sq.m	1,2
	Lecture Room	200-300	1	300 sq.m	2
	Toilet		5	150 sq.m	G,1,2
	Handicap Toilet		5	25 sq.m	G,1,2
		Total	3438 sq.m		
Exhibtion Gallery	Function	User	Quantity	Area	Fl
	Collection Gallery			1000 sq.m	3,4
	Indoor Gallery			1716 sq.m	3,4
	Archive Room		2	180 sq.m	3,4
	Storage		2	251 sq.m	3,4
	Toilet		2	60 sq.m	3,4
	Handicap Toilet		2	10 sq.m	3,4
		Total	3274 sq.m		
Service	Function	User	Quantity	Area	Fl
	Workshop (Dirty Work)+ Storage		1	363 sq.m	G
	Electric Room		1	20 sq.m	G
	Security Room		1	20 sq.m	G
		Total	403 sq.m		
Total Floor Area 7115 sq.m					

Table 1. 3 Table of programming

5.3 Site analysis

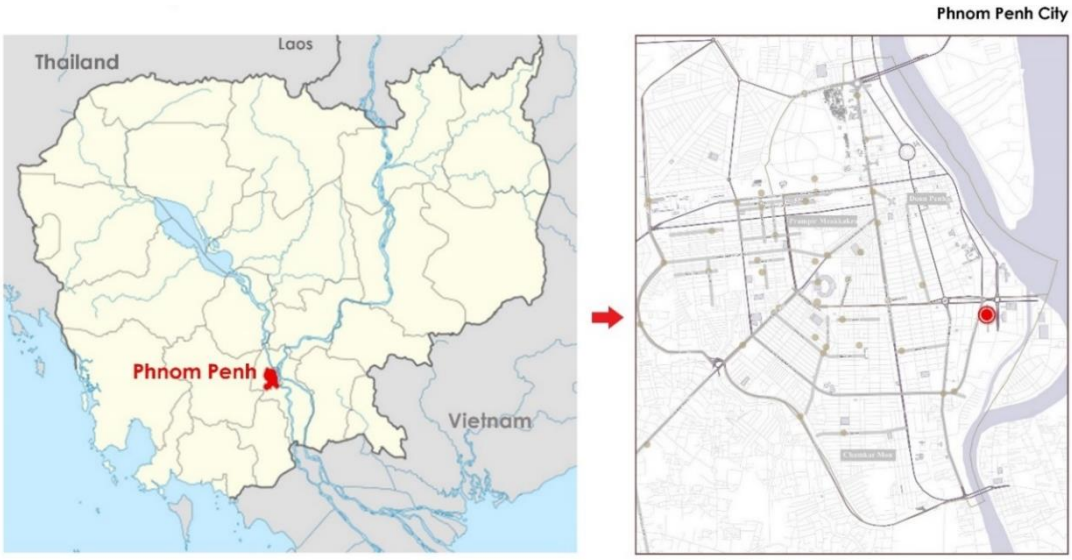


Figure 5. 1 Site Location (source: Google Earth)

The site of this thesis is located in the middle of Phnom Penh city in Cambodia (Fig. 5. 1). The selected area will consist of a small section — around 6,045 square meters — of the total size of a vacant plot that, in the past, was used to house a modern architecture building referred to as “White Building Apartment”. In existence for five decades, this place had developed a reputation as an iconic sight in the city. However, due to the structurally unsound condition of the building and the space crunch faced by the residents, where a lot of limitations in terms of land value and space were making its optimum utilization impossible, the government purchased and demolished the building in 2017. This five-decade old building is planned to be replaced by new contemporary commercial high-rise buildings (Phnom Penh Post, 2017) (Fig. 5. 2).

As stated in Chapter 4, the White Building has a long story with regard to the “art community”. It is mainly home to a business, shop, non-profit art school, art gallery, library, and street vendor in addition to being home to hundreds of families. The residents in the White Building were mix of embattled artisans, including musicians, classic dancers, painters, writers, embroidery experts, and skilled craftsmen. With the

spiritual programs it hosts, the location is very suitable for a new design of a contemporary art space, since the place is generally considered as an art area.

Figure 5. 2 White Building Apartment before and present

5.3.1 Accessibility

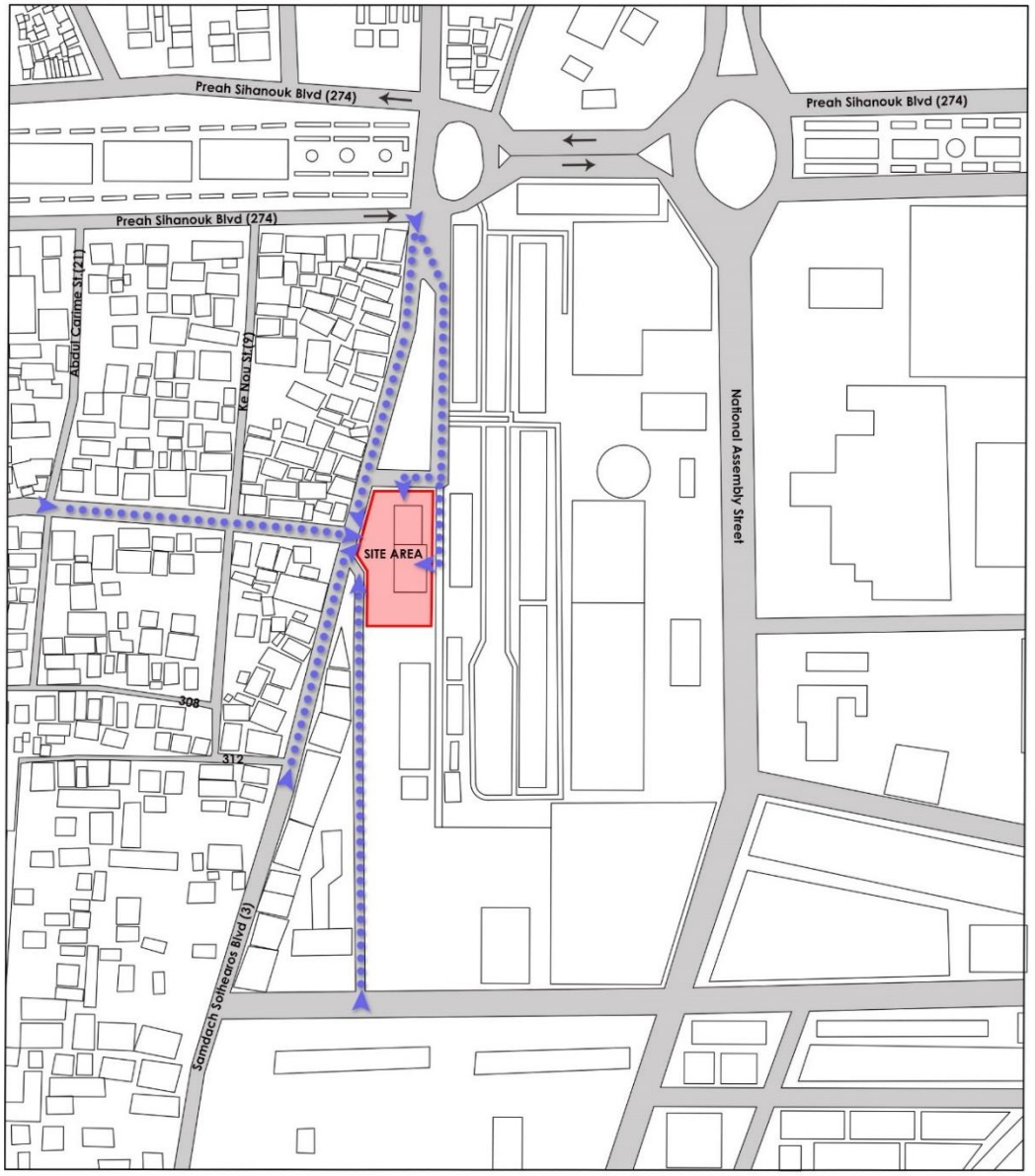


Figure 5. 3 Diagram showing ways of site approaching

5.3.2 Surroundings

The site located in one of the most potential areas surrounded by many amenities such as educational institutes, shops, green areas, residential buildings, and many other services, near the Bassac riverside that people visit for leisure activities (Fig. 5. 4, 5. 5, 5. 6).

The initial orientation of the site toward:

East: Row of shop houses, generally business and residence

South: Vacant land plot alongside former White Building site

West: Phnom Penh Center building site — parking lots, restaurants, offices, and BBU university

North: Green space

Figure 5. 4 Diagram land use patterns and landmarks

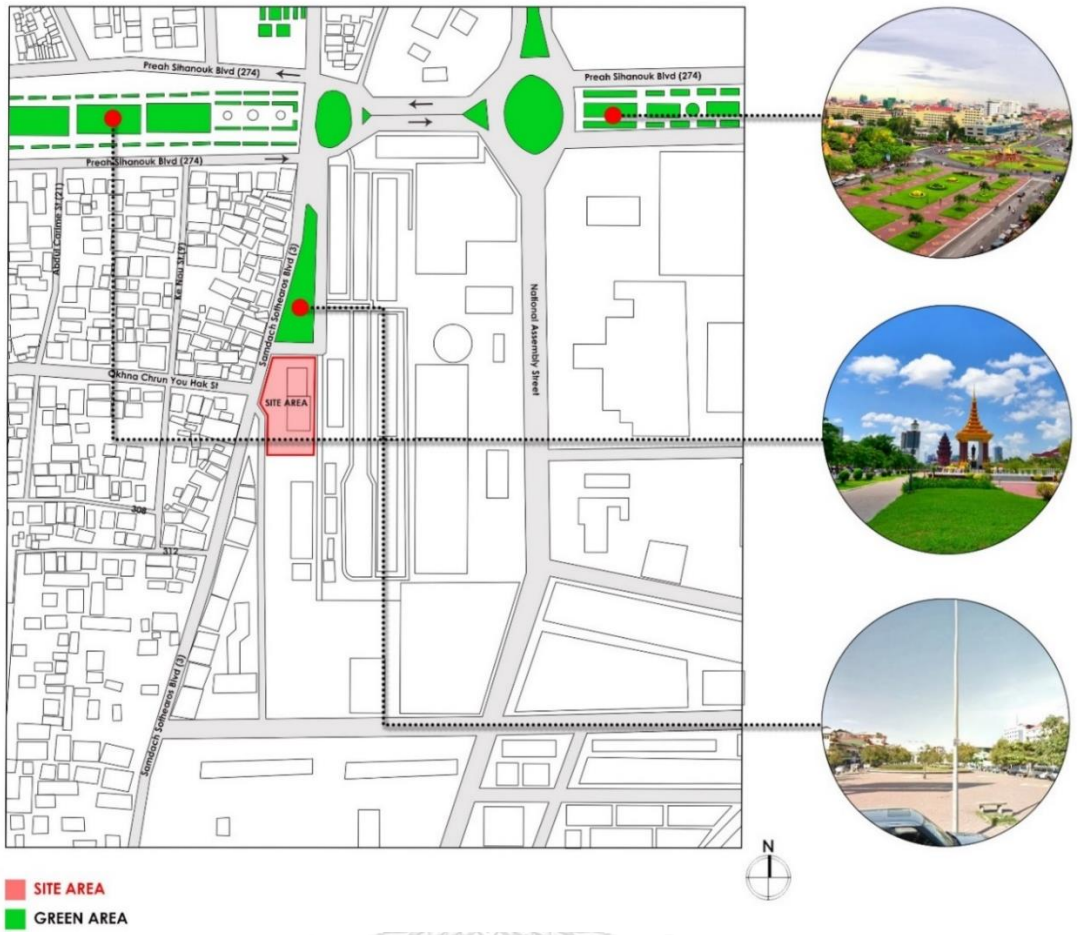


Figure 5. 5 Diagram land use patterns of green area

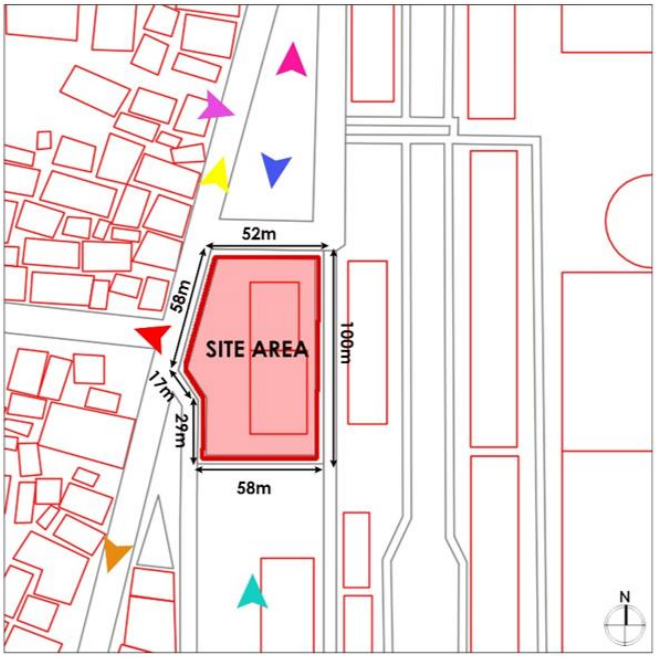


Figure 10. Site specification

Figure 11. View from south toward site

Figure 12. View from west elevation (Source: Google Earth)

Figure 13. Sothearous Blvd.

Figure 14. Green space.

Figure 15. View from south elevation

Figure 16. View from north Elevation toward green space.

Figure 17. View from green space toward the site.

Figure 5. 6 Vista around the site

5.3.3 Law and Regulation

According to law and regulation of Cambodia:

CHAPTER 1: NATURE, LOCATION AND SIDEBOARD TO THE CONSTRUCTION AREA

ARTICLE 30. CONSTRUCTION BORDERING PUBLIC ROUTES

30.2 Construction shall be built along the demarcation lines of the public routes or further out at least 4m of the demarcation.

CHAPTER2: LOCATION ANS SIZE OF CONSTRUCTION

ARTICLE 8: For adjacent lots, construction shall be erected either as a joint wall or a minimum distance of 2m from the boundaries of the lots. This 2m space shall be left free from the constructions, Windows or doors in joint walls shall be prohibited.

ARTICLE 35: BUILDING TO GROUND RATIO

For building of at least 15 living units, hotel, offices building and factories, the construction to ground ratio shall be not exceed 50% of the area of the lot. The unbuilt area of the lot shall br used for garden with a water absorbed ground on at least half of its area.

ARTICLE 36: HEIGHT

This plan shall take into account:

Existing average height of each zone.

The main characteristics of the zone (commercial, residential, factory, downtown or outskirts, elevated or non-elevated terrain, servitudes linked to infrastructure, etc.)

CHAPTER3: CONSTRUCTION SPECIFICATION

ARTICLE 38:

The construction permits shall be denied for construction, which by their situation, their architecture, their size or their external characteristic of such nature as to clash with the character or the interest of neighboring site, the urban or natural landscape, the serenity of cult places, the archaeology or historical site, the palace and royal monument. (MLMUPC, 2016).

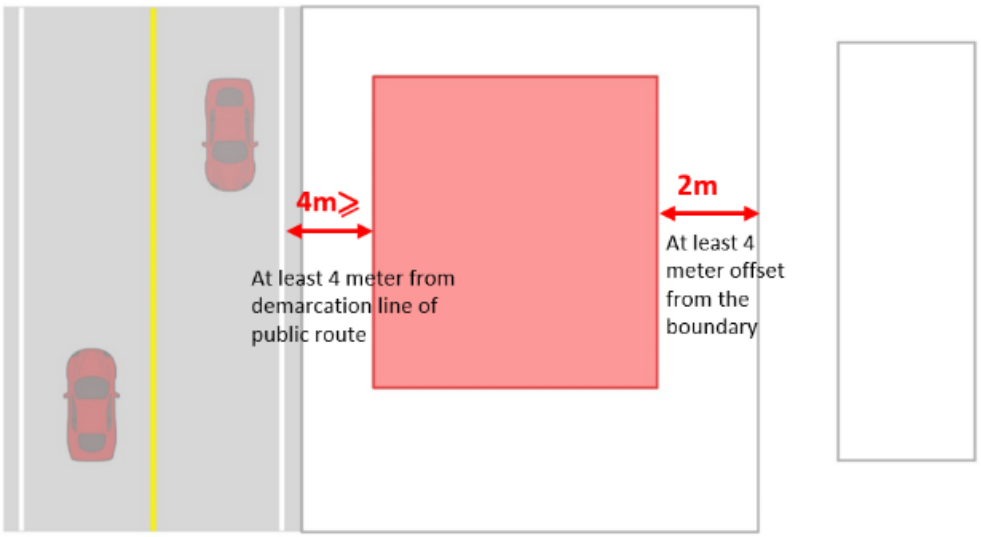


Figure 5. 7 Diagram summary the law and regulation of the location and size of construction

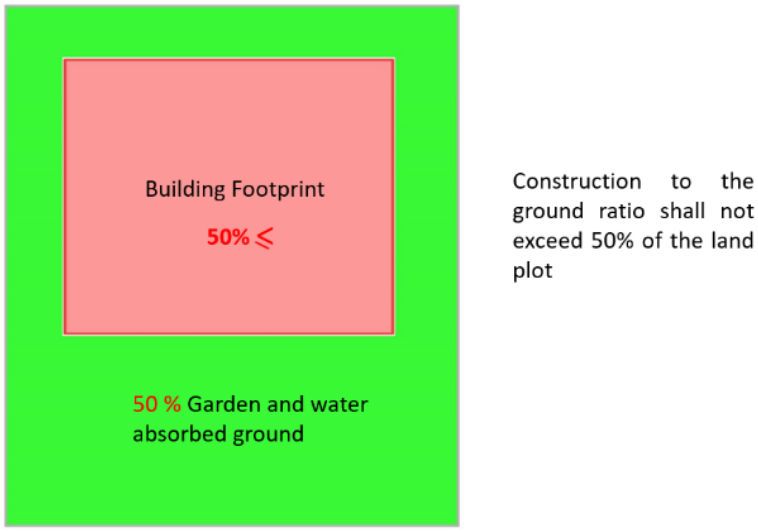


Figure 5. 8 Diagram summary the law and regulation of building to ground ratio

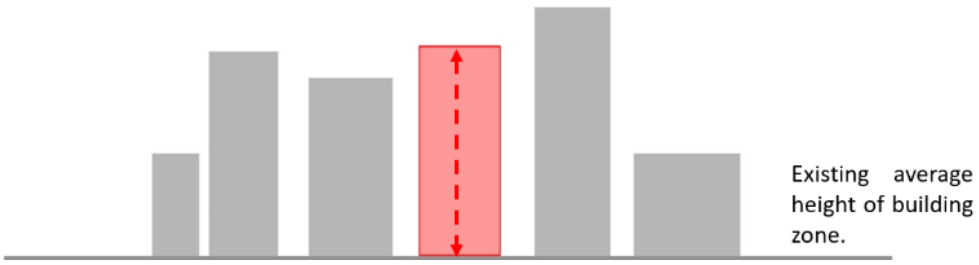
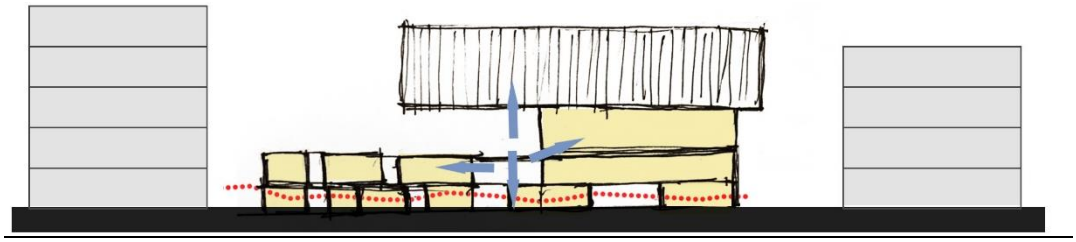


Figure 5. 9 Diagram summary the law and regulation of building height

5.4 Design Concept



The main design concept entails the creation of an art community and propagation of art activities for Cambodia. This art community will provide an opportunity to the local in the area to appreciate contemporary art, which will lead to the rise of new artists. Furthermore, this will enable the public to utilize the site space in a way that is more useful to the community. Designed with an aim to bring into being an active art community, the gallery building has provisions for other rooms to be modified to function as other entities, such as a restaurant, library, studio space, and shops for renting. Therefore, the building will be used for a variety of purposes. However, the various activities to be conducted in the art gallery will be held in different areas of the building and not necessarily in the intended gallery space. The different affiliations of the gallery, such as the restaurant, the library, or the public space outside the art gallery can be used for other art related activities concerned with art that are primarily meant to fascinate those people who are not acquainted with contemporary art.

Due to the unaffordability of high energy-consuming buildings system, this new art space should function with consideration for sustainability. Thus, the sustainable approach is the key factor with regard to this project. In this design, the Vann Molyvann's architectural strategies are ideal as the main guideline. His innovative strategies will help this big cultural public space design to achieve moderate energy expenses, since the building may not have sufficient resources to afford fully an air-conditioning system.

The building will be mainly divided into two zones — the lower part will be reserved for the public and the community hosting those facilities for support of the

building, while the upper part will serve as a gallery space that is more private by virtue of the different nature of activities conducted there. Moreover, the building is designed in this manner due to operational reasons, which include efficient functioning of the various activities in the gallery building. The gallery space has been planned in the upper section, because its operations end earlier, and it requires more security and protection from noise. Nonetheless, the supporting facilities can operate late, till midnight. Therefore, the planned locations are ideal for serving the public, unlike the gallery, which serves a relatively small number of people on a daily basis. This design will make control of the building easy and efficient.

5.5 Design development

The aim of the current project is to redesign a Cambodian art space with a view to increasing its appeal to the general public, reducing internal congestion by improving its ventilation, and enhancing its overall security system. Consequently, the first key step involves formulating the design concept that facilitates the development of the art space.

A six-step design concept is adopted. In the first step, cuts are crisscrossed through the project site in order to create multiple accessibility, more façade, and generate an interesting space. The second and third steps entail generating retail space in between the leftover space of the cut line, thereby leading to an increased platform. The platform serves two key roles. First, it provides links between retail spaces on the ground and upper floors, thereby facilitating free circulation and second, it provides space to undertake art-related activities such as outdoor exhibitions, among others. As such, the platform promotes adequate exploration of the gallery building, especially to an audience unfamiliar with contemporary art.

In the fourth step, an extra floor layer is added by playing with negative and positive volumes in order to make the space more active. A vertical design with a characteristic multipurpose terrace is adopted for the layer, thereby giving users more visibility between the two floors. In the fifth step, the main gallery is placed on the upper part of the building. The placement is motivated, in part, by the nature of

activities taking place in the gallery and the need for privacy. A central staircase is provided to enable movement to and from the gallery. The diagram below summarizes the six-step design concept (Fig. 5. 10, 5. 11).

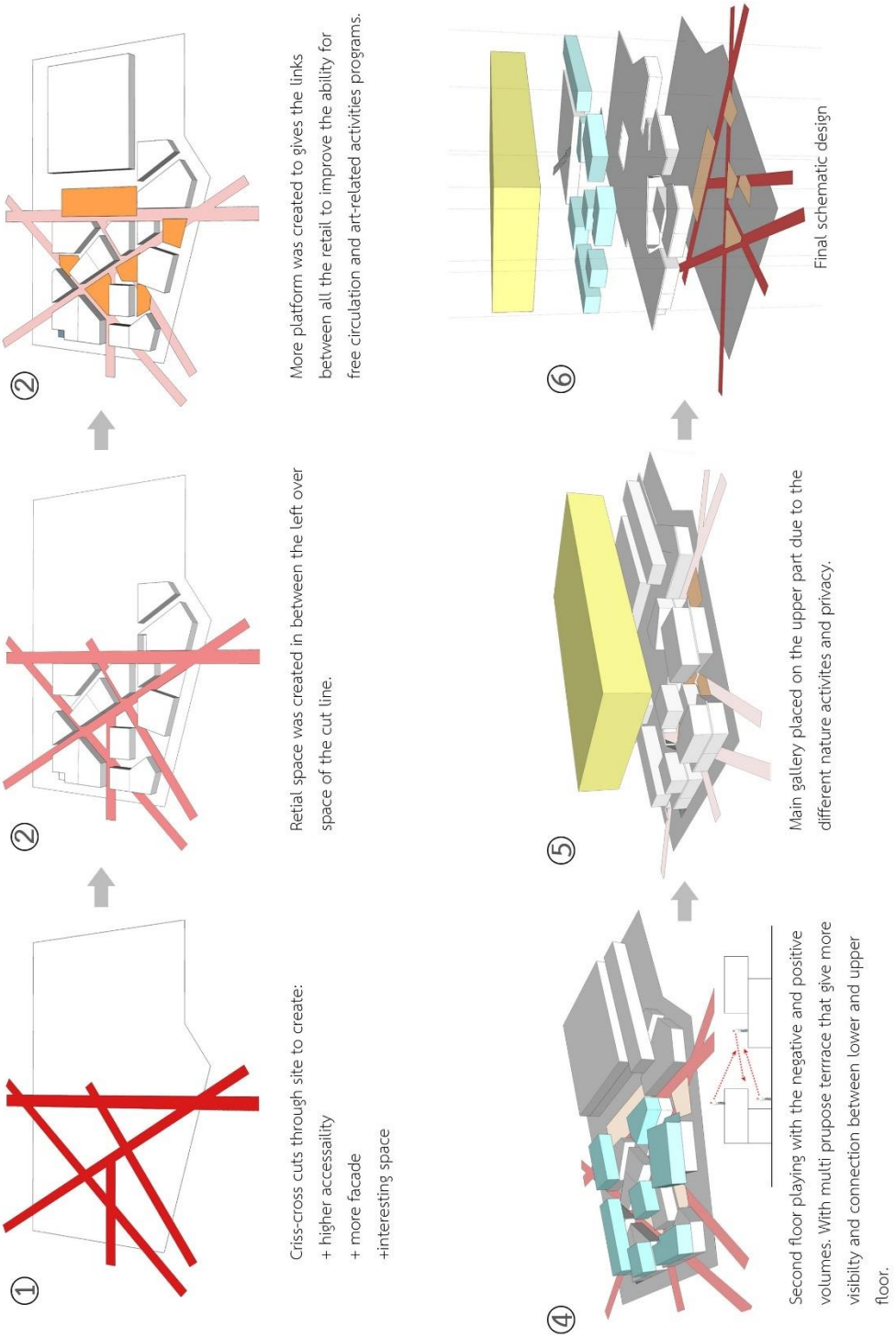


Figure 5. 10 Diagram design concept describes the different steps involved in formulating the final schematic design for the contemporary art space

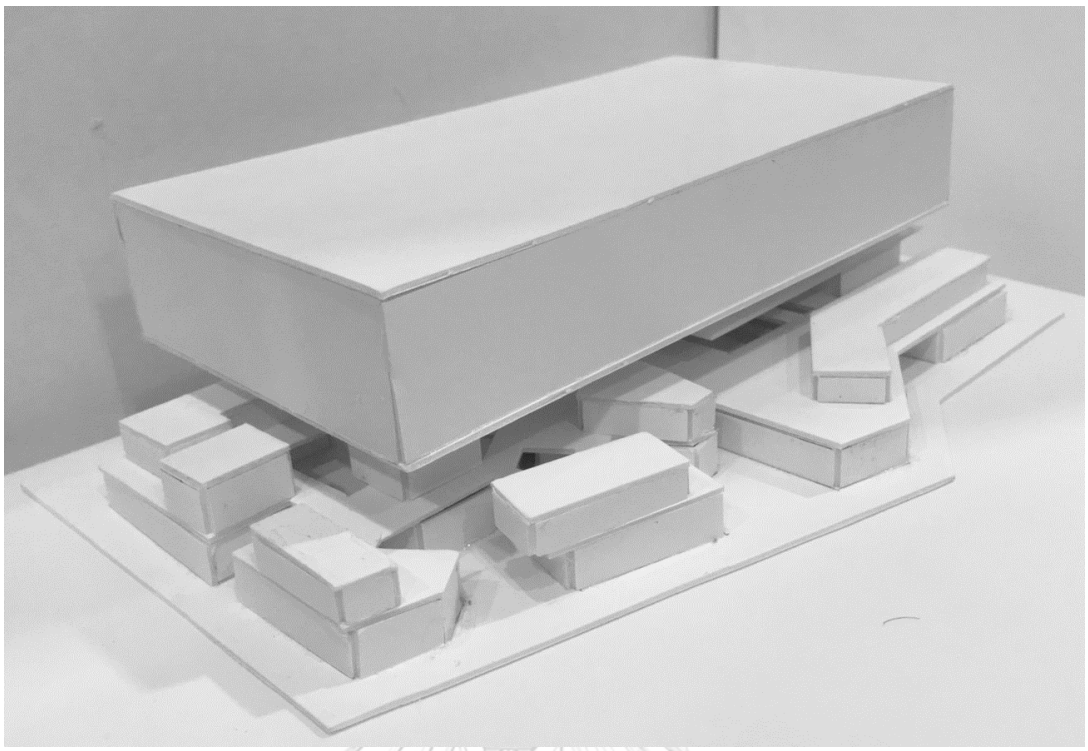


Figure 5. 11 Final volume of building

A restaurant, shop, pub, and rental space are located at the building's front part, which comprises the lower zone, ground, and first floors. Given that the building is to be built at minimum costs, Van Molyvann's sustainable principles are adopted in the design. As such, no air-conditioning equipment is installed.

Instead, the building has perforated walls to allow free flow of air, improving ventilation, and creating higher visibility for public users by allowing sunlight to permeate during the day. It is also important to note that the overall design aims at supporting and accommodating different classes of people, thereby avoiding fancy structures. The lower zone is designed with perforated walls and the distribution of shops and restaurants in the building's front part (Fig. 5. 12, 5. 13).

Figure 5. 12 Shops, restaurants and rental spaces on the side of the building

Figure 5. 13 Shops, restaurants and rental spaces on the front part of the building

A studio, library, lecture hall, bookshop, and offices are located at the posterior section of the first and second floors, as it is less noisy. Similarly, this location offers easier control since the facilities close after the main gallery. An extensive staircase that connects the first and second floors acts as an amphitheater from where people

can watch performances in the lower floor. Additionally, due to its expansive size, people are able to undertake their work whilst seated on the staircase.

A large terrace placed above the second-floor shop serves as a cantilever, providing much-needed shade to the lower floor. In addition, it provides flexible space where people can sit and enjoy outdoor activities such as the mini-cinema as well as hosting performances. Consequently, such a design is reminiscent of the “White Building” where people used its main staircase as a meeting space and the building’s rooftop to undertake diverse activities such as performances, kids’ play area, and relaxation-related activities. (Fig. 5. 14, 5. 15).

Figure 5. 14 shows a traditional dance class activity taking part in the gallery section

Figure 5. 15 further shows the central staircase connected between the first and second floors

.

The main gallery is located in the building's upper zone, which is made up of the third and fourth floors. The gallery is further divided into three types of spaces. First, is the outdoor space (Fig. 5. 16), which is open to the lower section design and is best suited for flexible activities and installations, with its double floor height occupying the lower and upper floors. The second space (Fig. 5. 17), on the third floor, is best suited for small and moderate-sized artwork (either sculptures or paintings), media arts, and special artwork that requires highly controlled environmental conditions. Since the artworks are not too large, the gallery's volume is not so high. Finally, the third type of space (Fig. 5. 18, 5. 19), located on the fourth floor, is designed to utilize natural lighting.

Vann Molyvann's sustainable strategies are also widely adopted in the main gallery's design. The gallery has double walls, with the outer layer wall being perforated to facilitate ventilation, entry of light, and protection from rain (Fig. 5. 20). The space in between the inner and outer walls acts as a service area around the entire gallery. The Vann double roof technique is also employed to reduce the sun's

heat by allowing flow of air through the two roof layers. Additionally, a translucent ceiling is fitted to the building to soften natural light and heat falling from above.

To further increase the efficiency of the gallery, its design incorporates an operable wall (Fig. 5. 21) that can be easily closed and opened allowing natural ventilation into the gallery. As such, this alleviates the need to install electrical air-conditioning systems. Three alternative designs are proposed (Fig. 5. 22, 5. 23, 5. 24). Walls are also fitted with manually operable windows to facilitate ventilation. The window design has steel frame structures with hinges at its central section. The frames are then covered with smartboard material. It is also important to note that the gallery space on both floors can be further sub-divided to cater for the needs of artists who can only afford small spaces (Fig. 5. 25).

Figure 5. 16 First space open to outdoor

Figure 5. 17 Third floor gallery

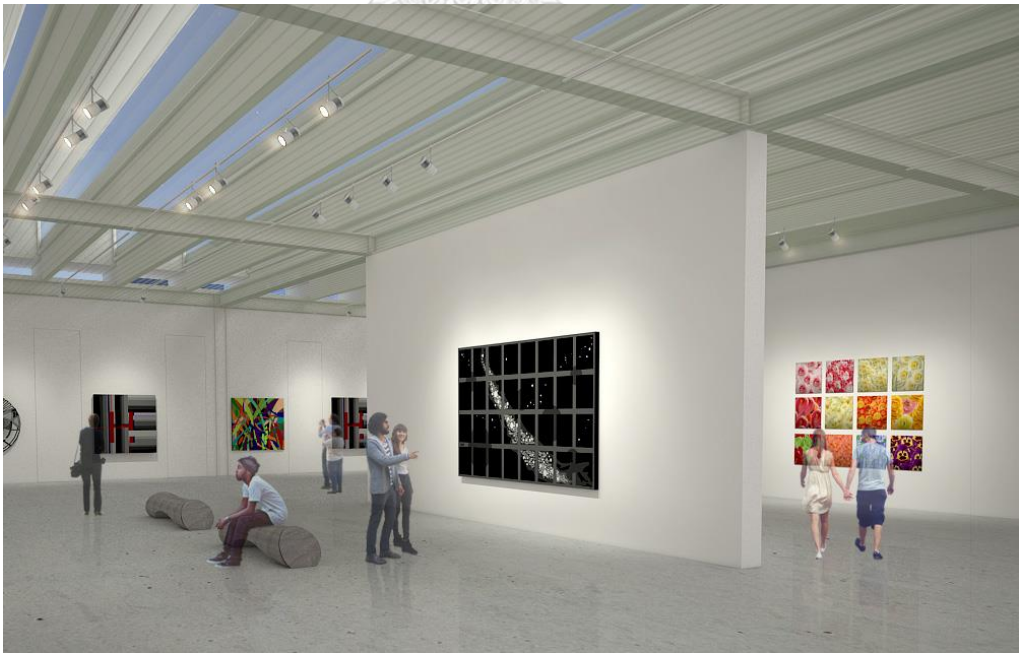


Figure 5. 18 Fourth floor gallery

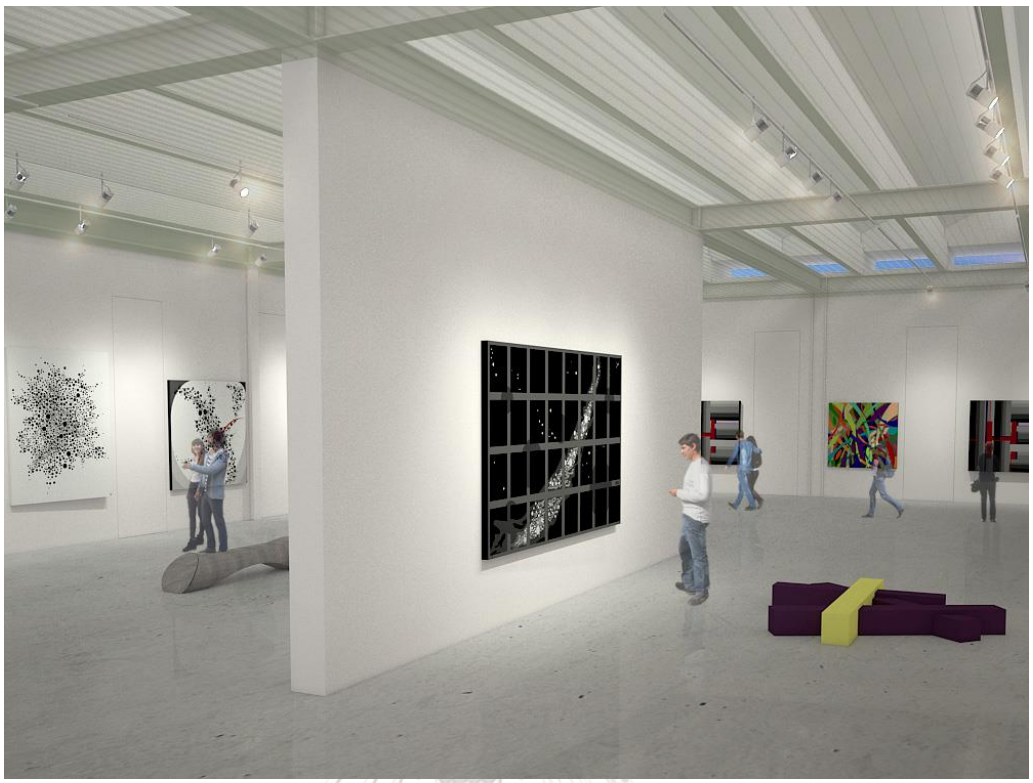


Figure 5. 19 Fourth floor gallery

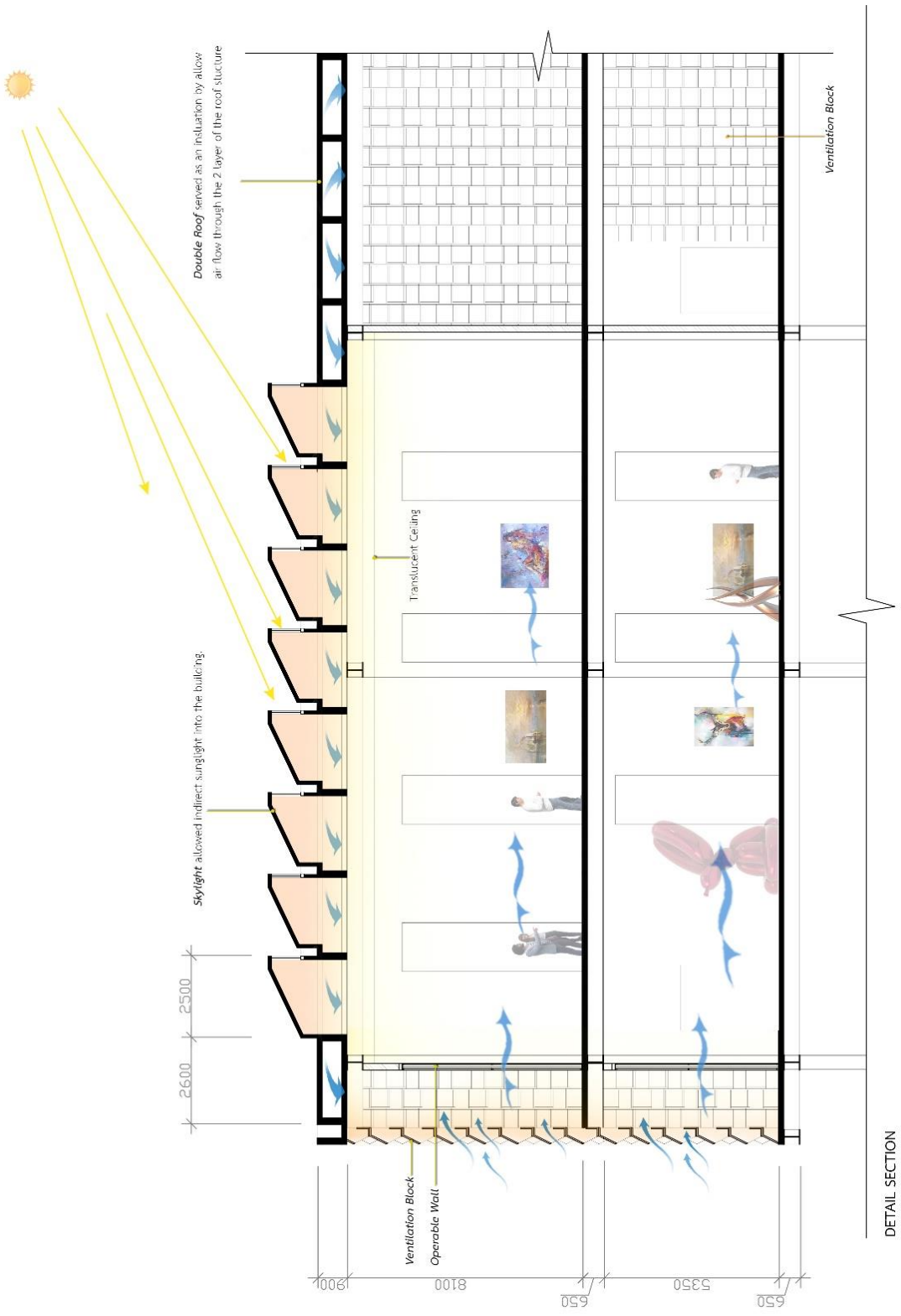


Figure 5. 20 Double roof and double wall design allowing ventilation and indirect light into building

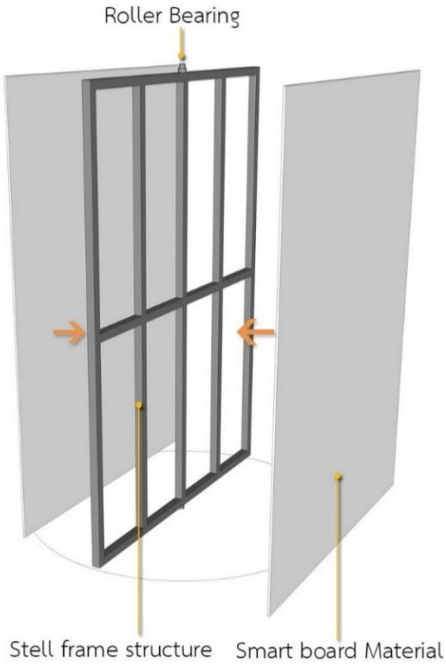


Figure 5. 21 Operable wall design

Option 1

Figure 5. 22 option 1 - functions as a window to get natural ventilation into the gallery space and functions as a gallery wall for art installation

Option 2

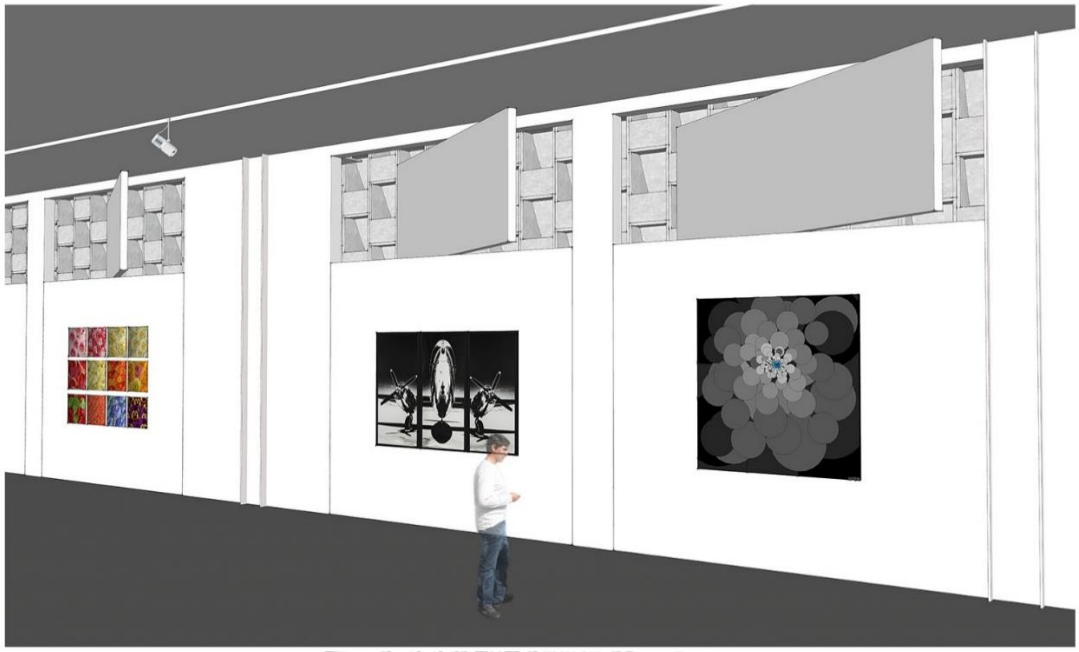


Figure 5. 23 Option 2 - operable wall opens only above the display wall

Option 3

Figure 5. 24 option 3 - smaller manually operable wall opens between the display walls

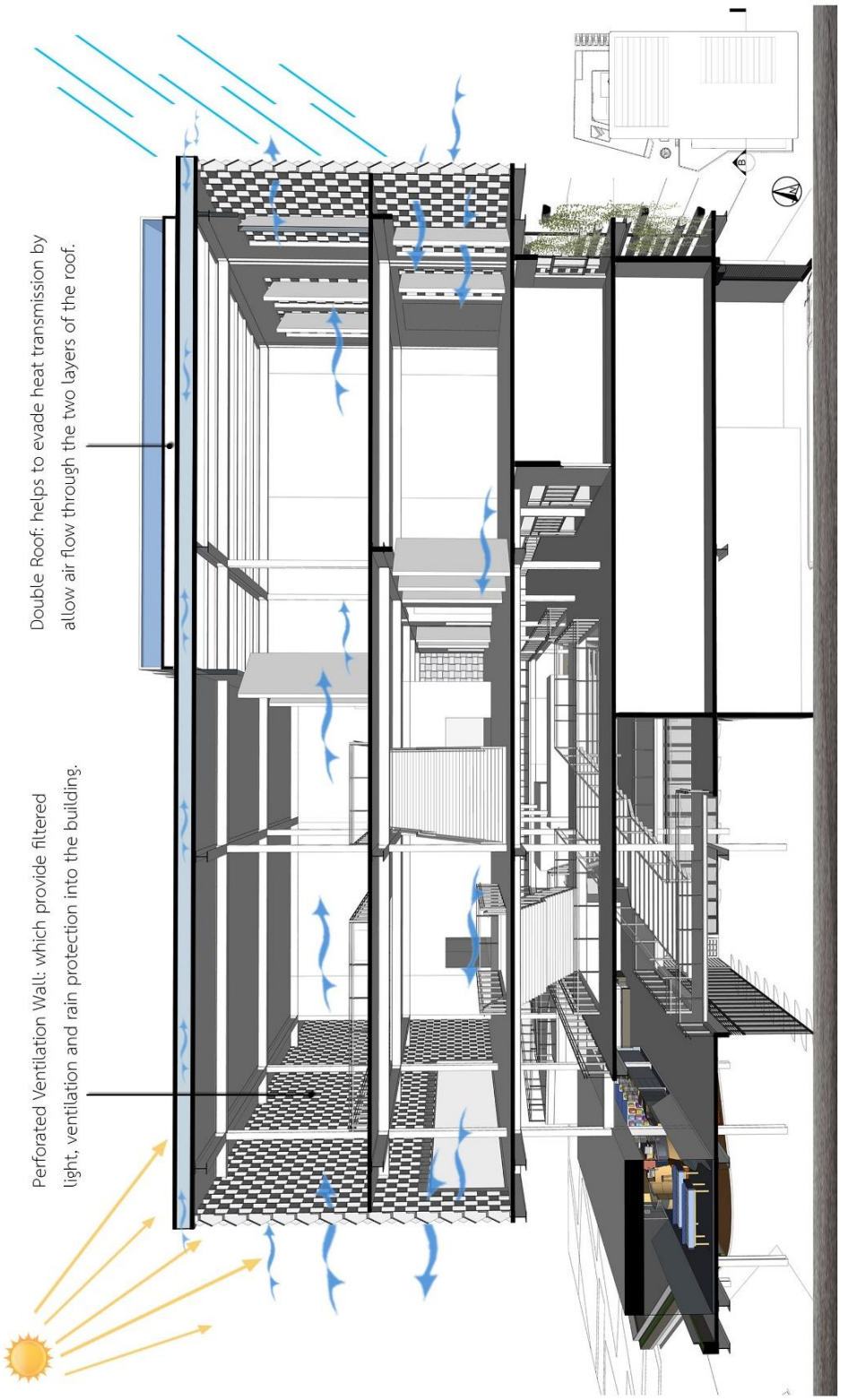


Figure 5. 25 Section B-B shows the design of the gallery which adopts Vann Molyvann's sustainable aspects

Material

The double wall's outer layer is made of GRC prefabricate ventilation block designed to mimic Vann Molyvann's buildings. In comparison, the 1960s wall ventilation offered light protection, but were less effective in rain protection, as heavy rain could pass through the side of the ventilation wall. The concrete materials were heavy, thick, and had weak reinforcement (Fig. 5. 26). The proposed ventilation wall will be efficient in light and rain protection. Moreover, it will have Glass Fiber Reinforced concrete (GFRC). The material will be lighter, thinner, and bigger, with a strong reinforcement (Fig. 5. 27).

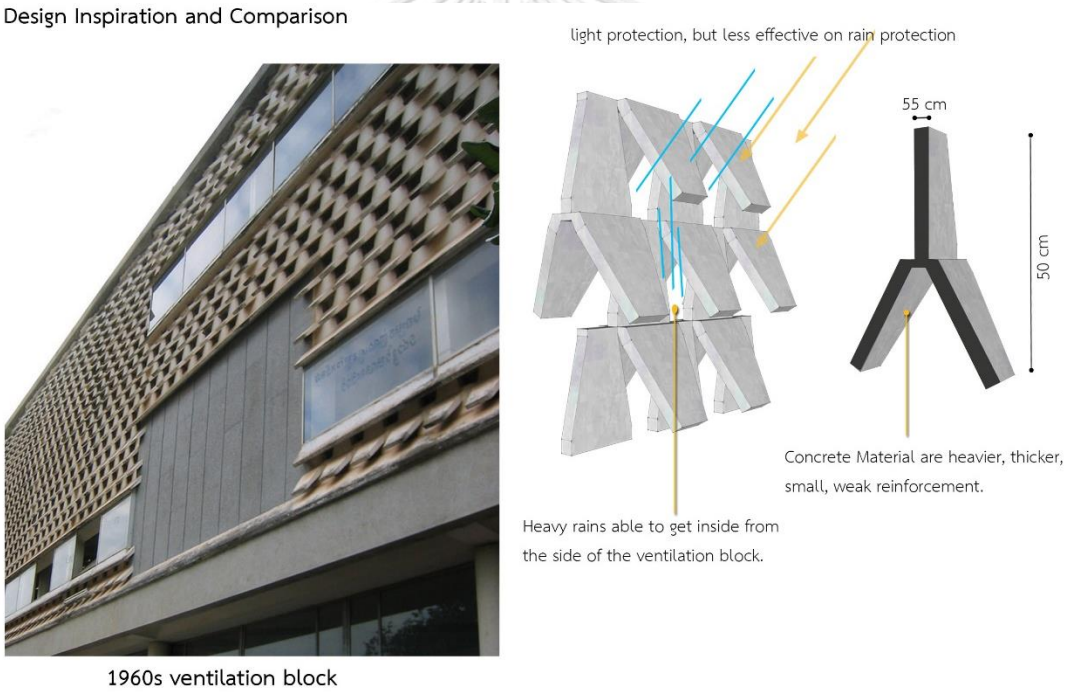


Figure 5. 26 1960s ventilation block.

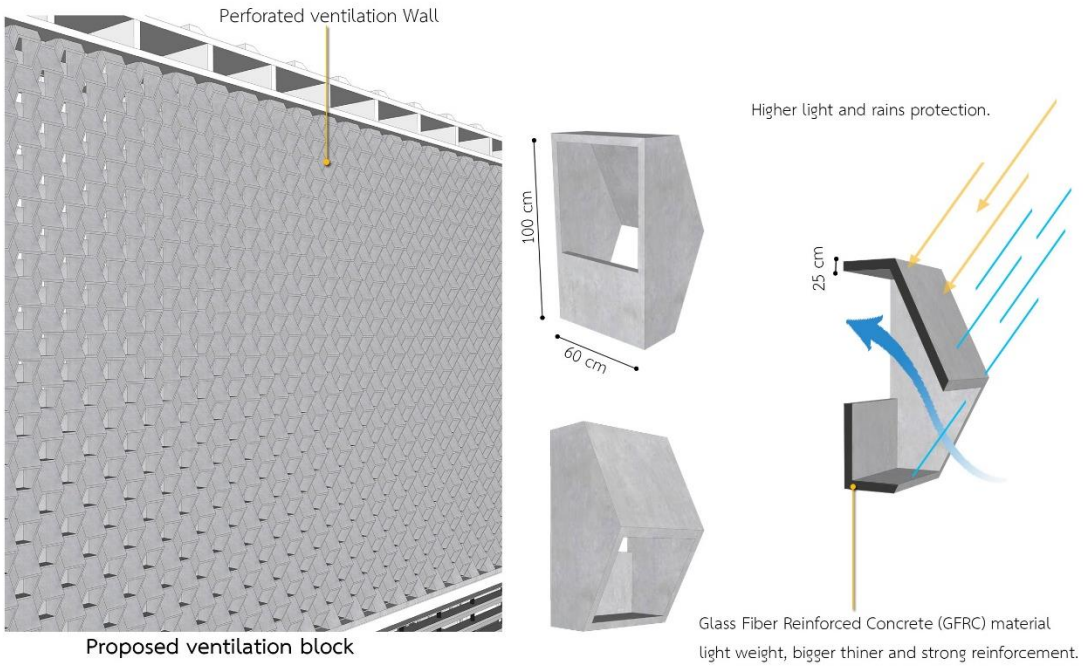


Figure 5. 27 Proposed ventilation block

5.5.1 Summary of the building's configurations adopting Van Molyvann tropical strategies

In order to facilitate the new design of the proposed Cambodian art space, Van Molyvann's tropical design strategies are adopted. The strategies emphasize on the need for sustainability by utilizing natural aspects such as direct sunlight for heating and natural ventilation and cooling with a view to reduce operational expenses arising from the implementation of electrical air conditioning systems. The strategies as summerised in chapter 3 are discussed as the main guidelines in this section: level off the ground; wall design; roofing; shading; program and orientation; and use of water.

The first strategy advocates for locating the main program building at a **level off the ground**. With the design, the main gallery is located on the upper floor thereby enabling its lower section to be utilized as a multipurpose space catering for diverse services such as parking, a restaurant, pub and rental space. The motivation for locating the main program at a level off the ground is to ensure privacy for the activities being undertaken therein. Similarly, the location of the restaurant and rental spaces at the

lower section is in part motivated by the need to reduce operational costs and in effect, offer affordable space to artists. Despite the rooms in the lower part being small, they are built independently in order to allow natural ventilation.

The second strategy regards the **wall** design. The main gallery has a double wall structure with the outer layer wall being perforated to facilitate free flow of air, improve ventilation, and create higher visibility for public users by allowing sunlight to permeate during the day ventilation while offering protection from rain and direct sunlight. The space in between the inner and outer walls acts as a service area round the entire gallery. The gallery is also observed to incorporate an operable wall that can be easily closed and opened allowing natural ventilation into the gallery and in effect, alleviates the need to install electrical air conditioning systems. In addition, the lower section where the pub, restaurant and rental spaces are located are redesigned with perforated walls thereby eliminating the need to install air conditioning equipment. As a result, this helps reduce the operation costs of the building and avails affordable space for the artists.

The third strategy involves the **roofing** where the main gallery is designed with a double roof in order to reduce the sun's heat by allowing flow of air through the two roof layers. In addition, the double insulation serves as an added insulation aspect. With improved ventilation and heat insulation, this reduces the mechanical ventilation expense in the building by eliminating the need for air conditioning equipment.

The fourth strategy regards **shading** where the new design focuses on providing shade to the lower floor section. As a result, top floors overhang the lower ones and in effect, create a geometrical impression and reinforce the shading aspect. The ground floors are also well designed with less glass facades and higher perforated brick walls that provide shade against direct sunlight while providing visibility and ventilation.

With the fifth strategy, **program and orientation**, indirect lighting is advocated where buildings are positioned away from direct sunlight in order to eliminate direct heating impact. Consequently, the main gallery adopts features that facilitate indirect lighting. For instance, the double wall protects the building from direct sunlight while ventilation offers a cooling effect. A translucent ceiling is also fitted to the gallery to soften natural light and heat falling from above. In addition, the top skylight is also

oriented towards the south direction in order to avoid indirect sunlight and eliminate solar heat gain. Such a design ensures best top lighting for the gallery while providing a flexible space idea.

The last strategy, use of **water** of Vann Molyvann's tropical strategy, is omitted due to several constraints in the project. A pool facilitates rain water drainage from the roof top and offers a passive cooling technique through evaporation. As well, it provides efficient air circulation within the building. On the contrary, it is not implemented in the new redesign due to the fact that it is associated with high maintenance costs through daily cleaning. Given that the project aims at sustainable practices, routine maintenance processes consume high expenses hence being eliminated.

Similarly, a different school of thought argues that in order to provide efficient passive cooling, the pool requires to be relatively large in size due to the overall size of the building and number of occupants. The challenge arises due to the site constraint in the building as it is required to support additional facilities such as the restaurant and pub. To provide such a big area of water as a pool could prove in contrary to be unsustainable due to high maintenance.

5.6 Final design: architectural drawings

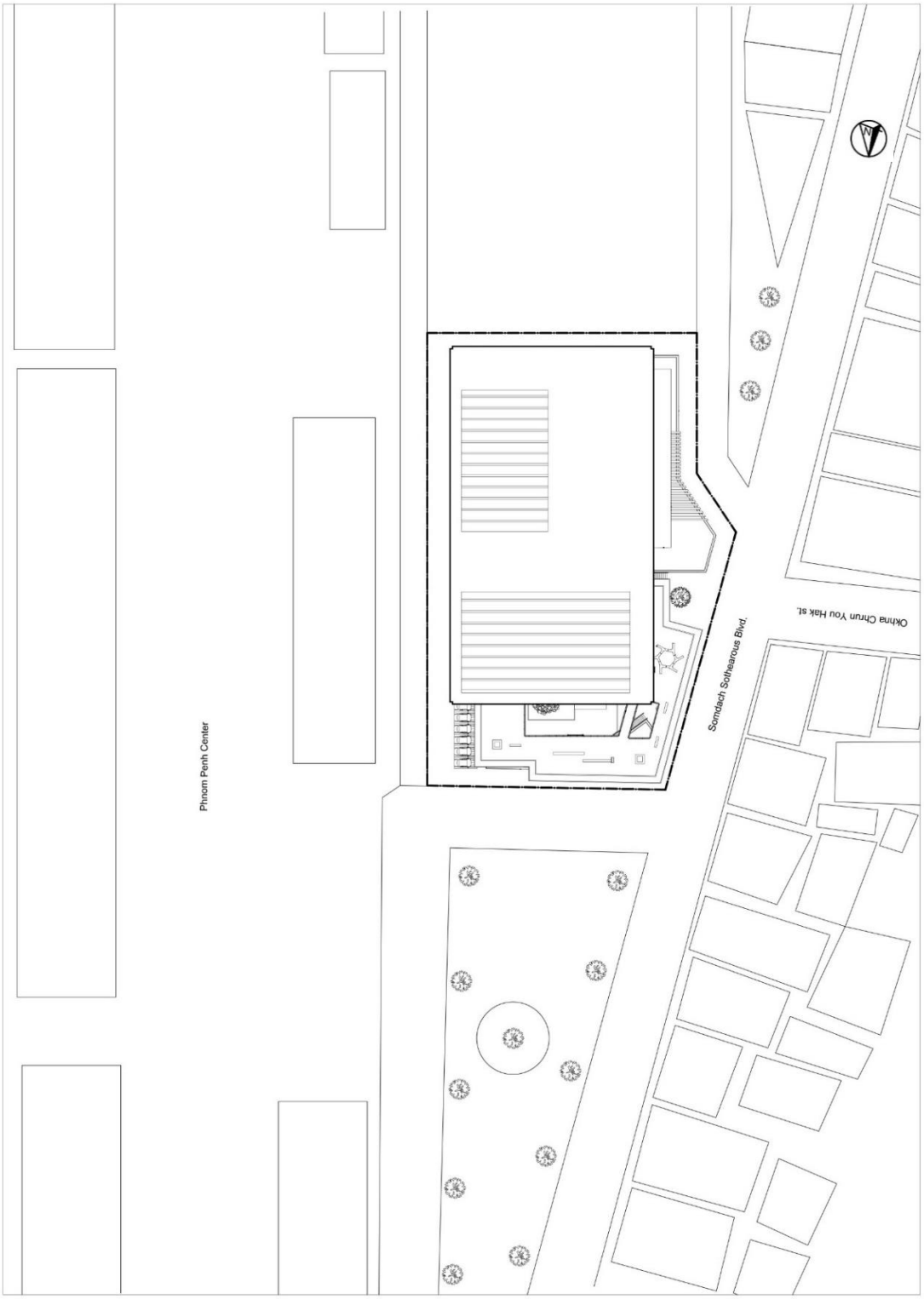


Figure 5. 28 Roof plan with location

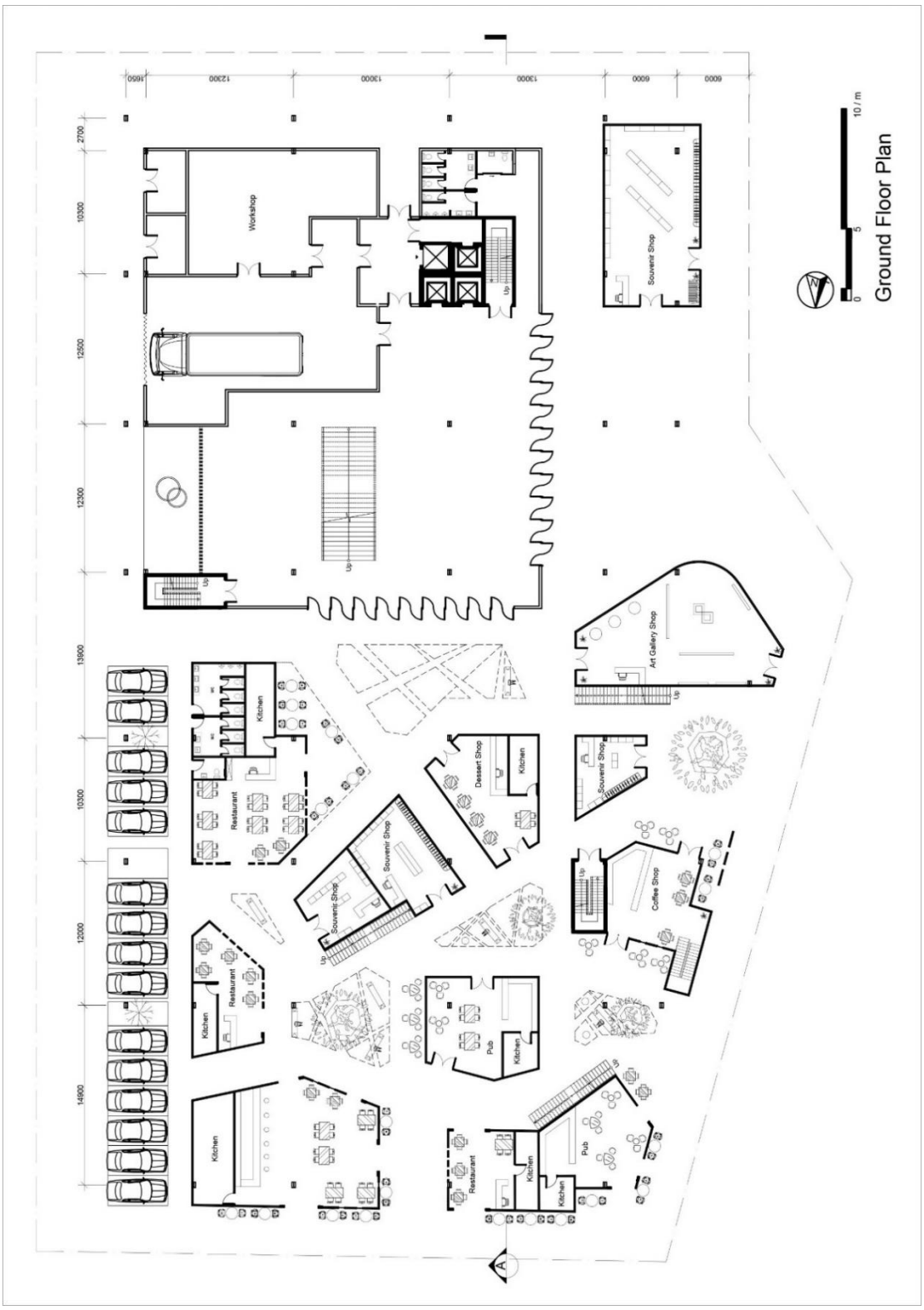


Figure 5. 29 Ground floor gallery

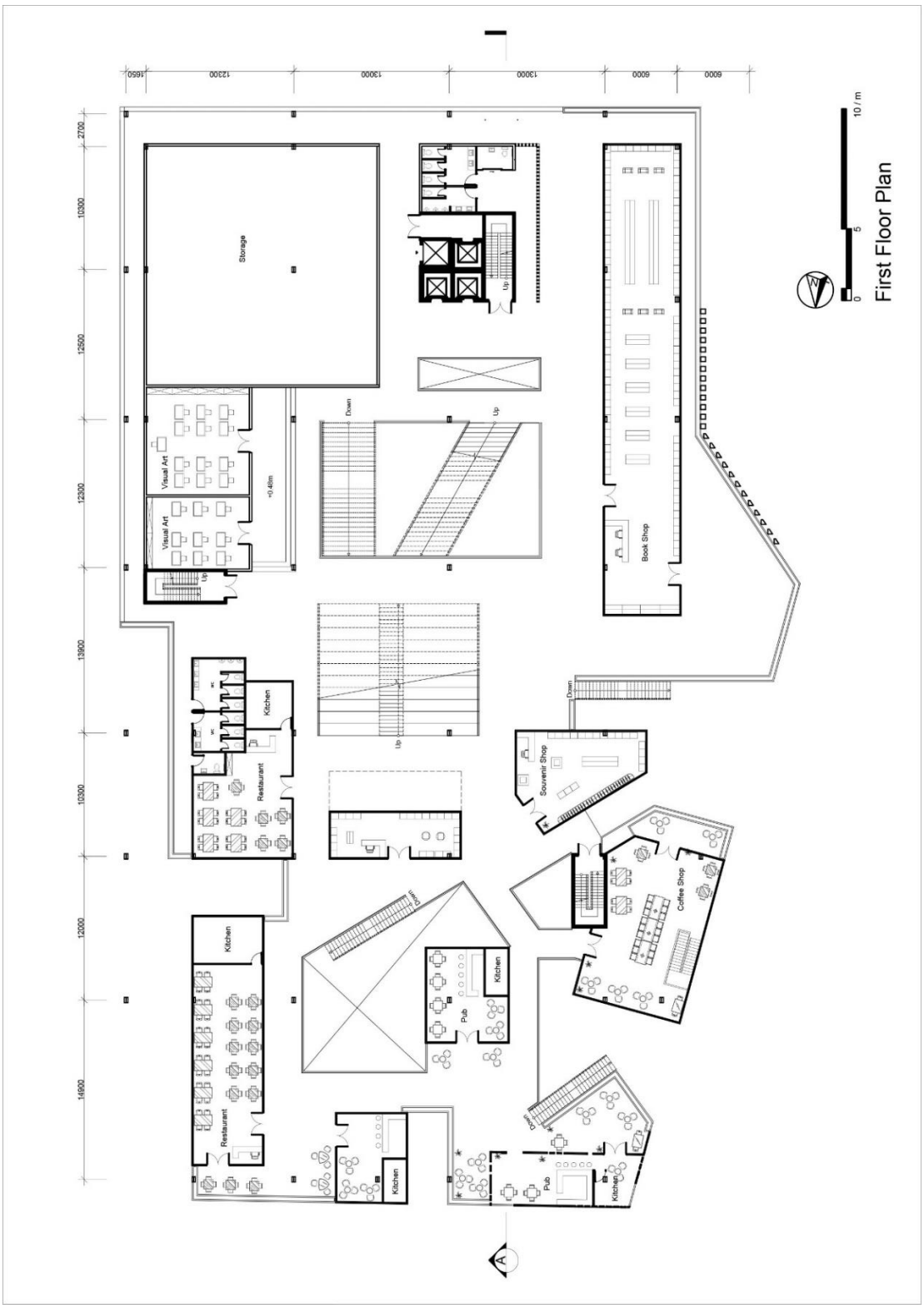


Figure 5. 30 First floor gallery

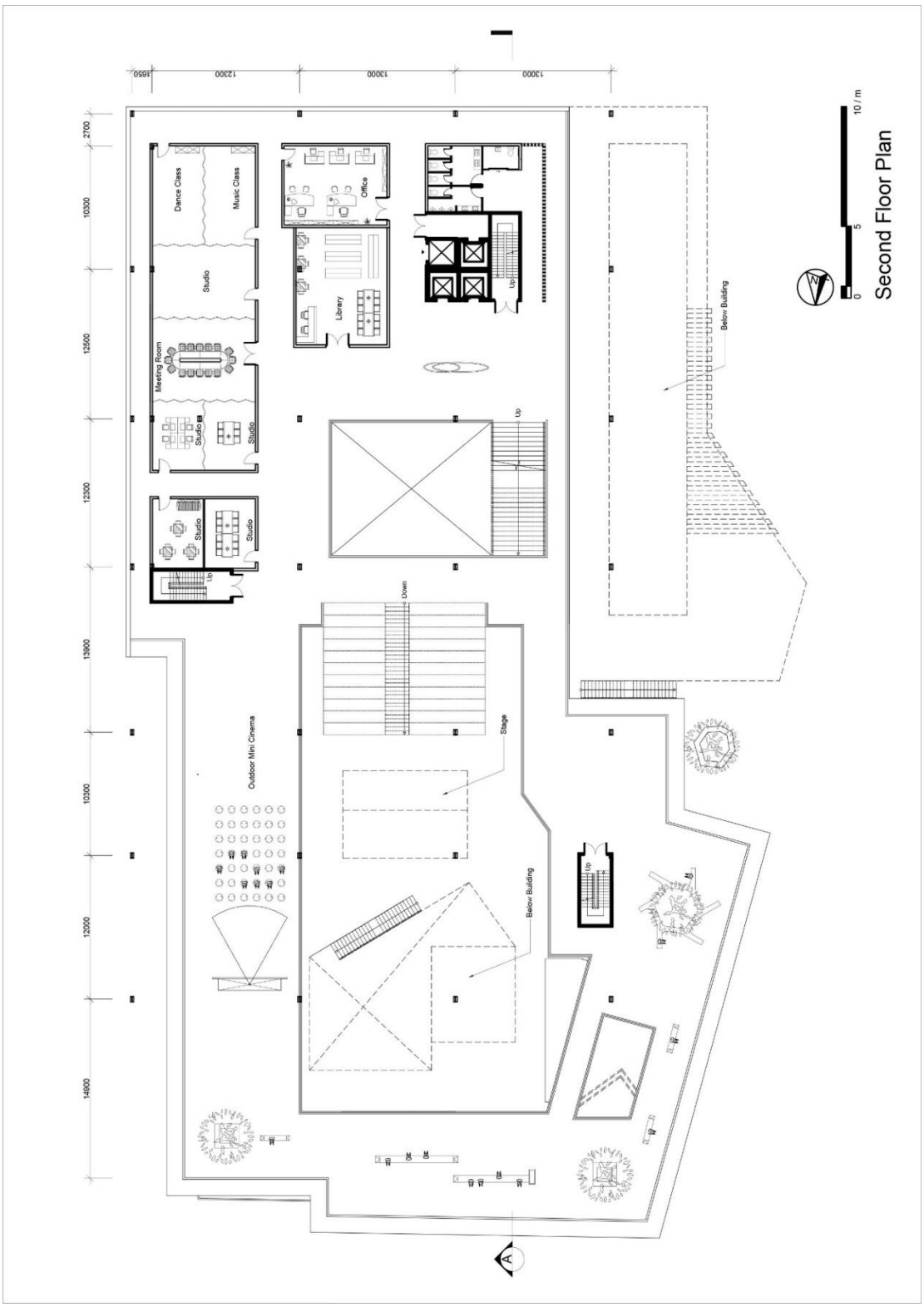


Figure 5. 31 Second floor gallery

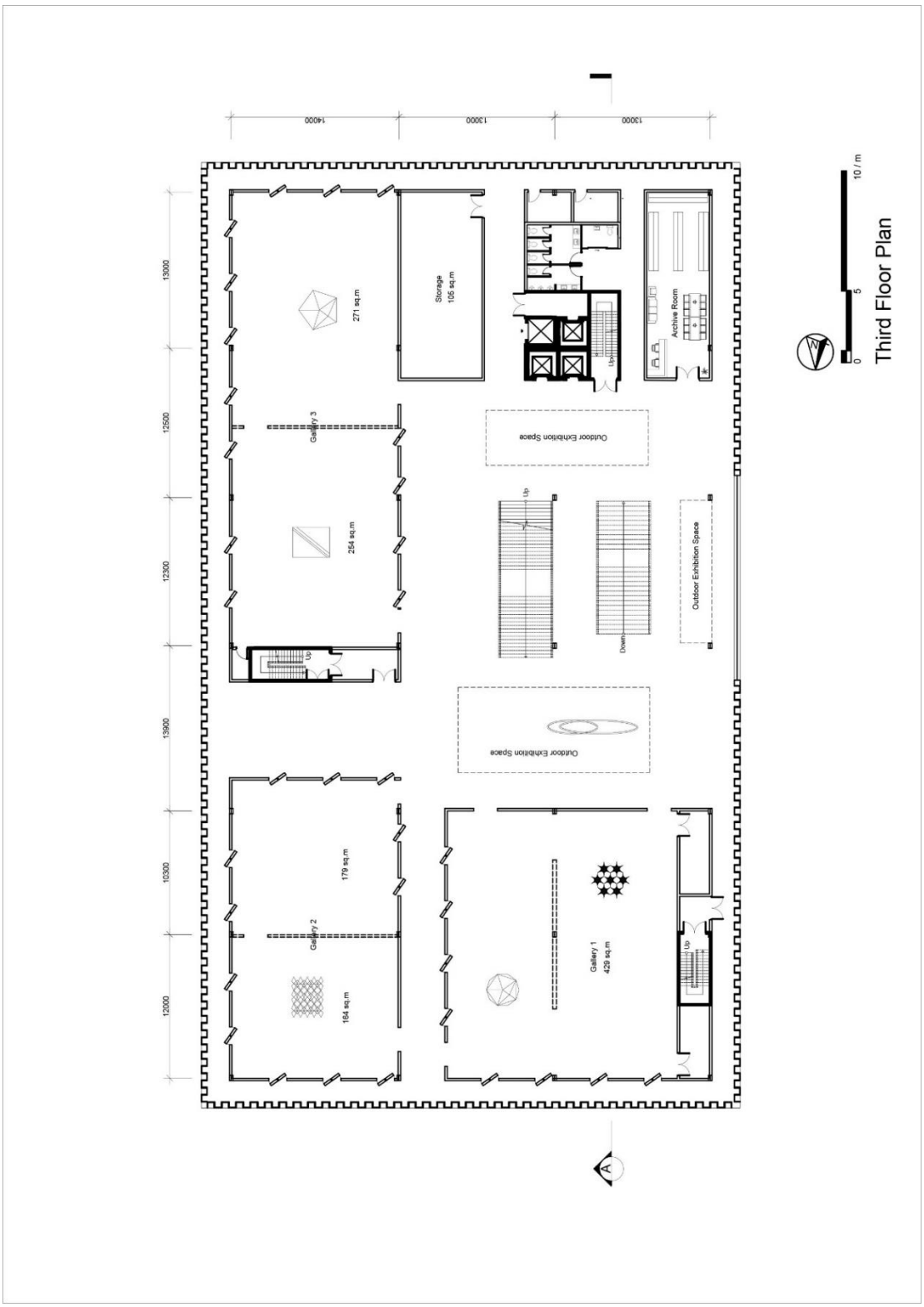


Figure 5. 32 Third floor plan

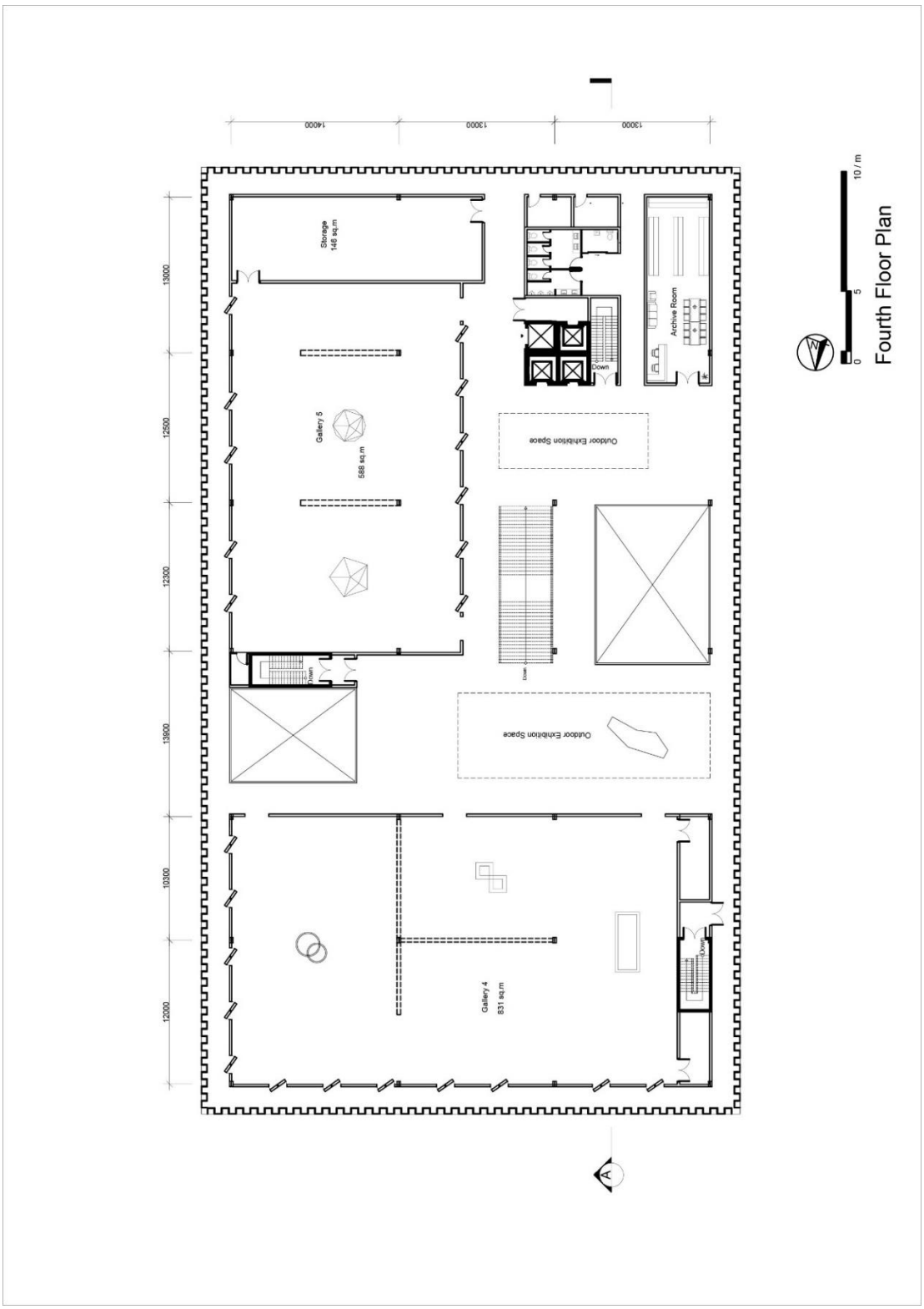


Figure 5. 33 Fourth floor plan

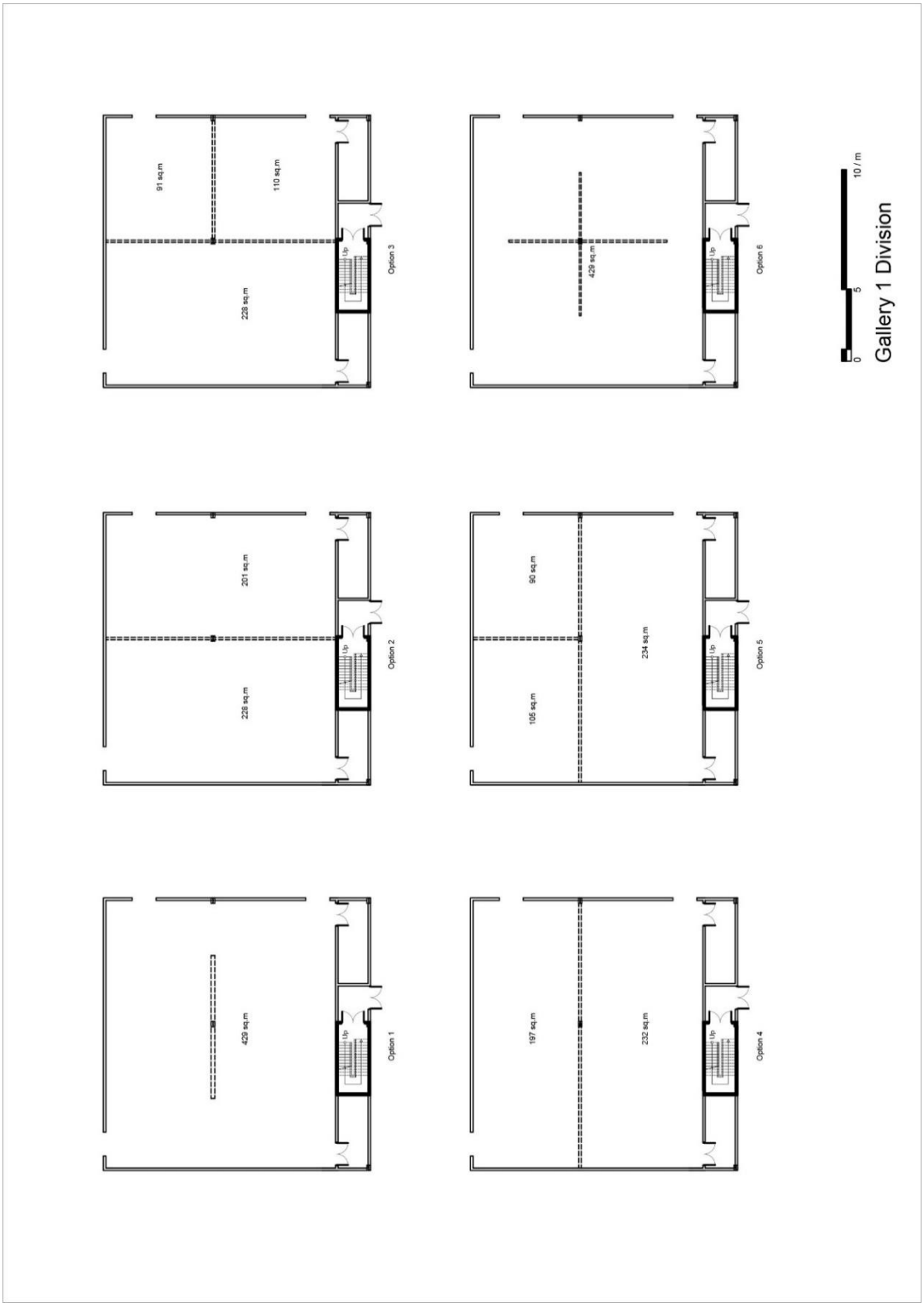


Figure 5. 34 Gallery 1 division

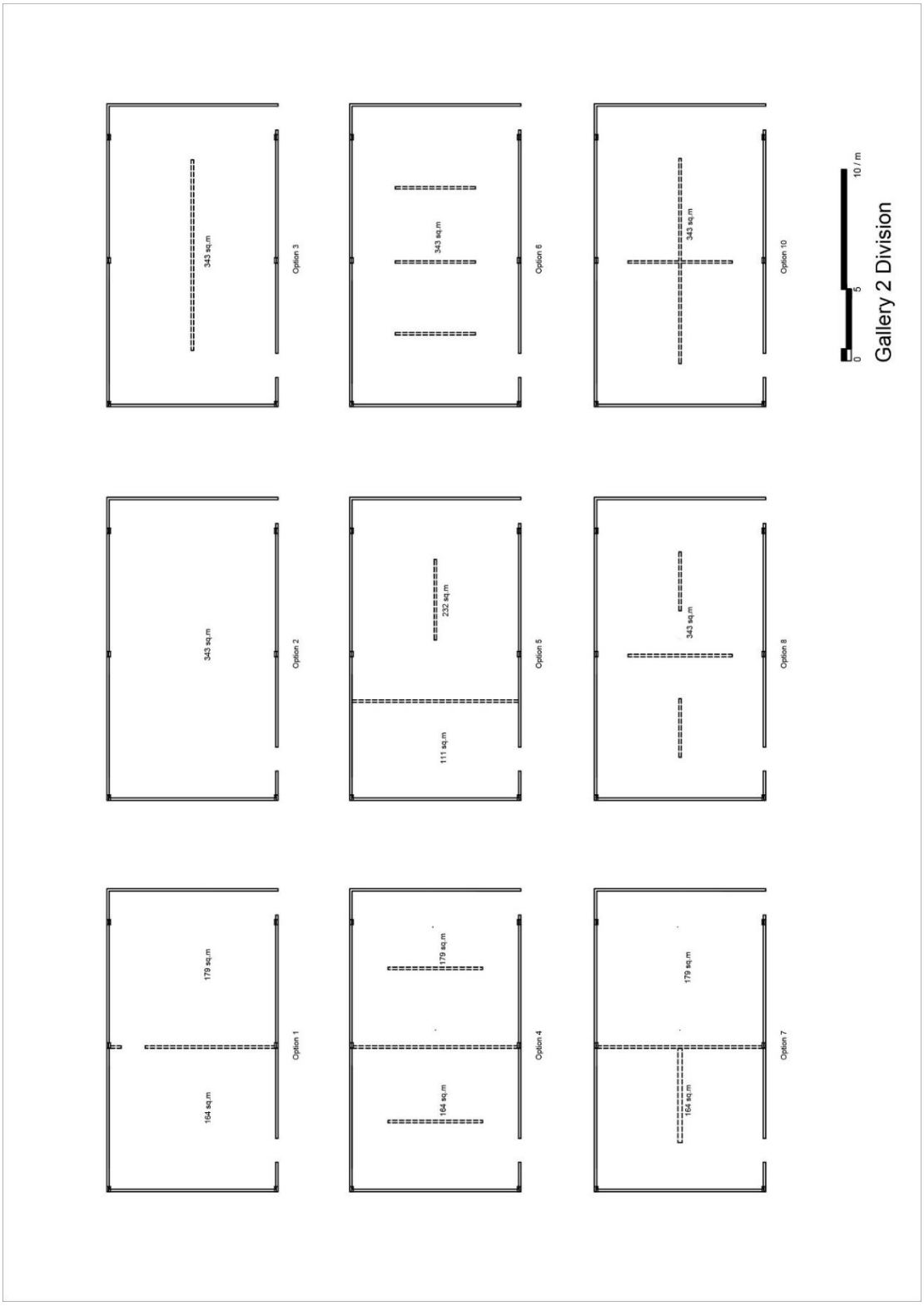


Figure 5. 35 Gallery 2 division

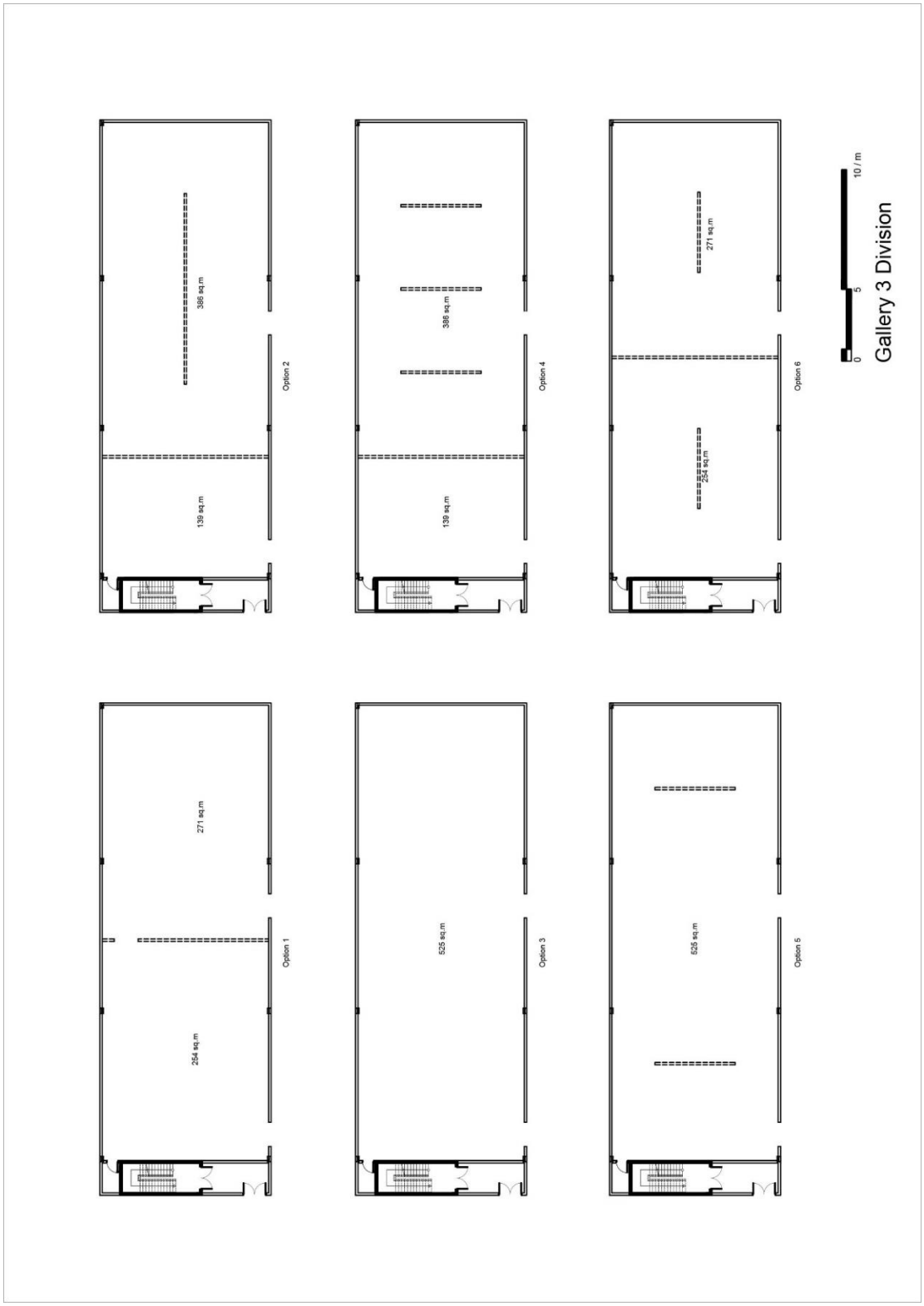


Figure 5. 36 Gallery 3 division

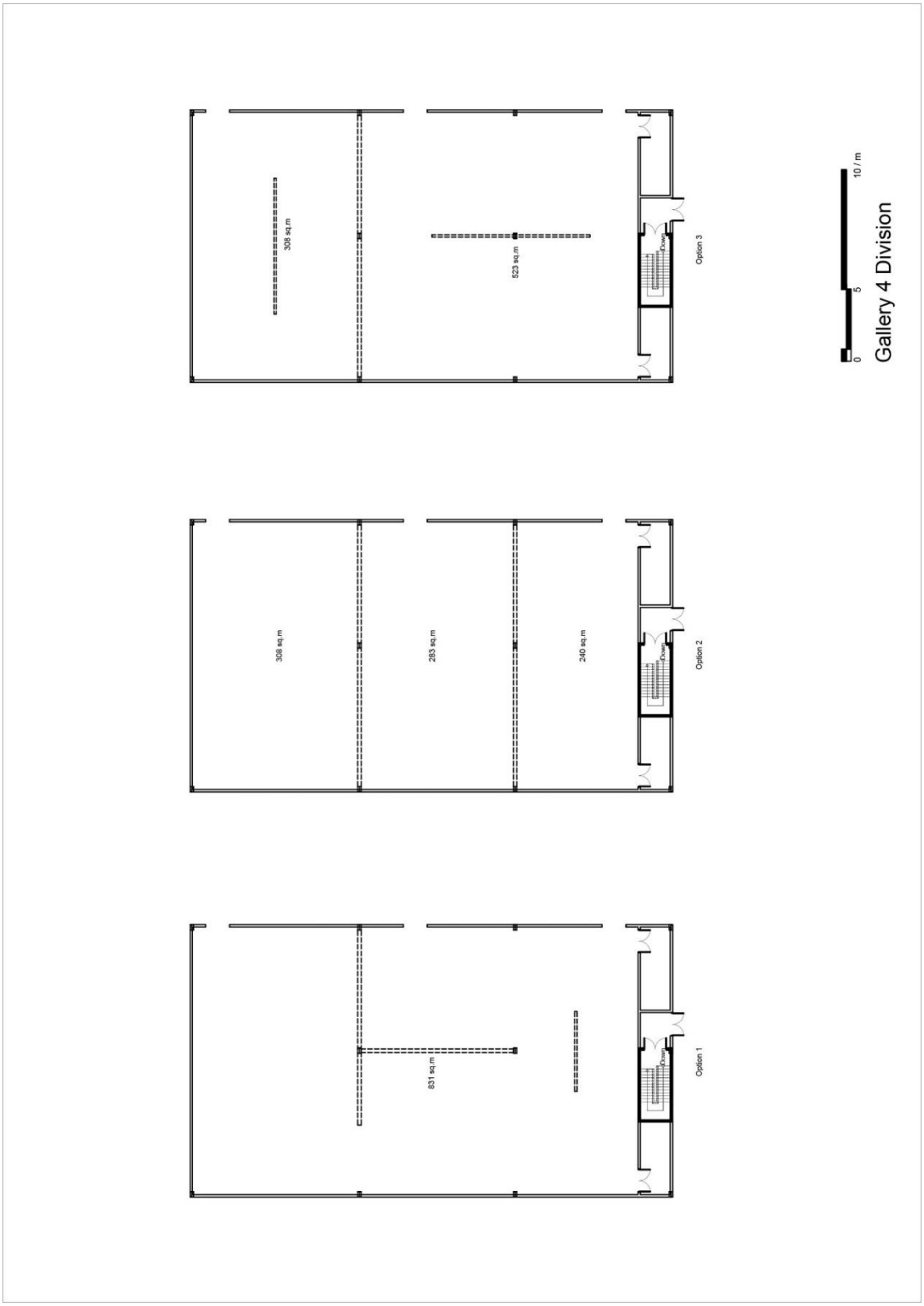


Figure 5. 37 Gallery 4 division

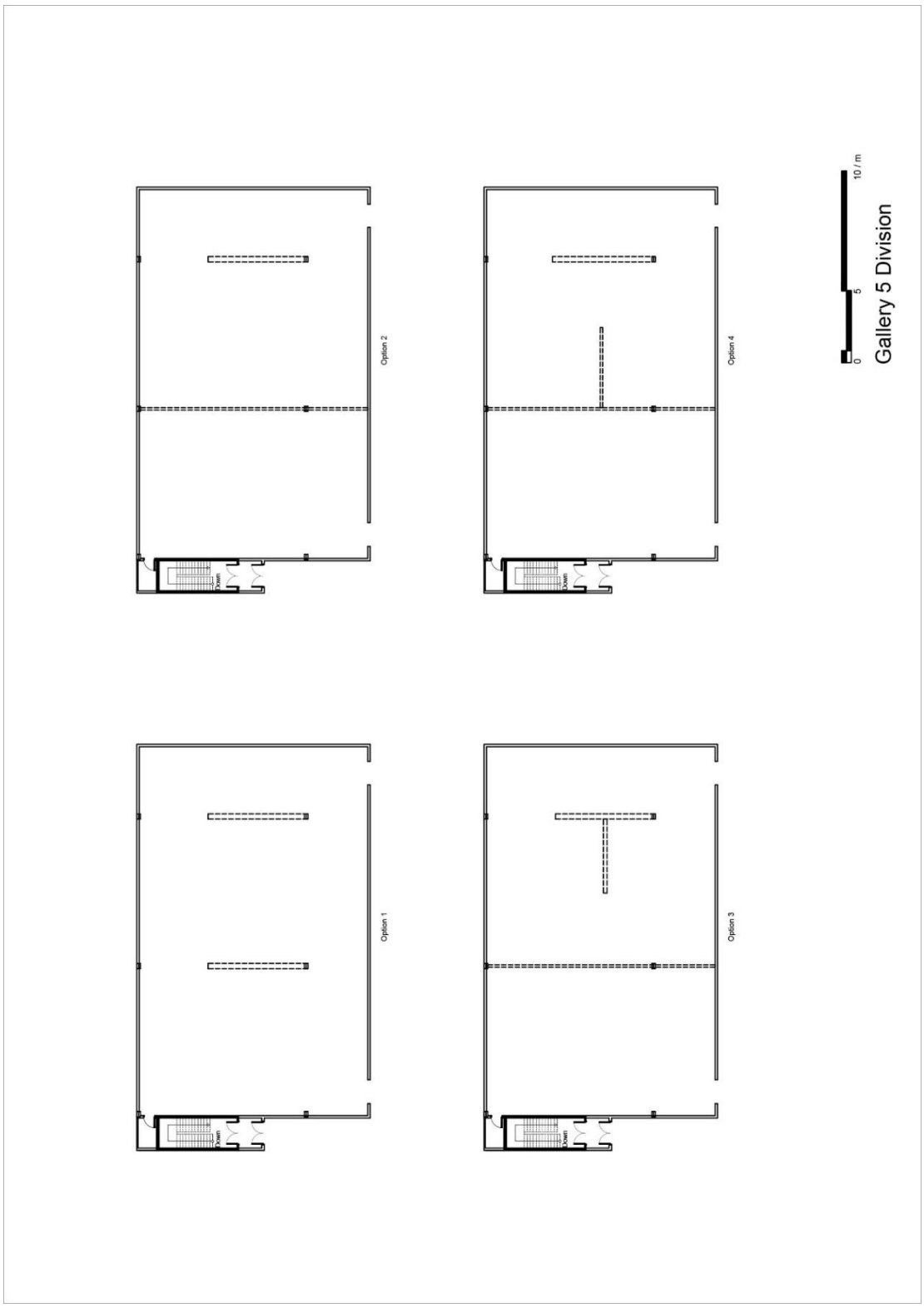


Figure 5. 38 Gallery 5 division

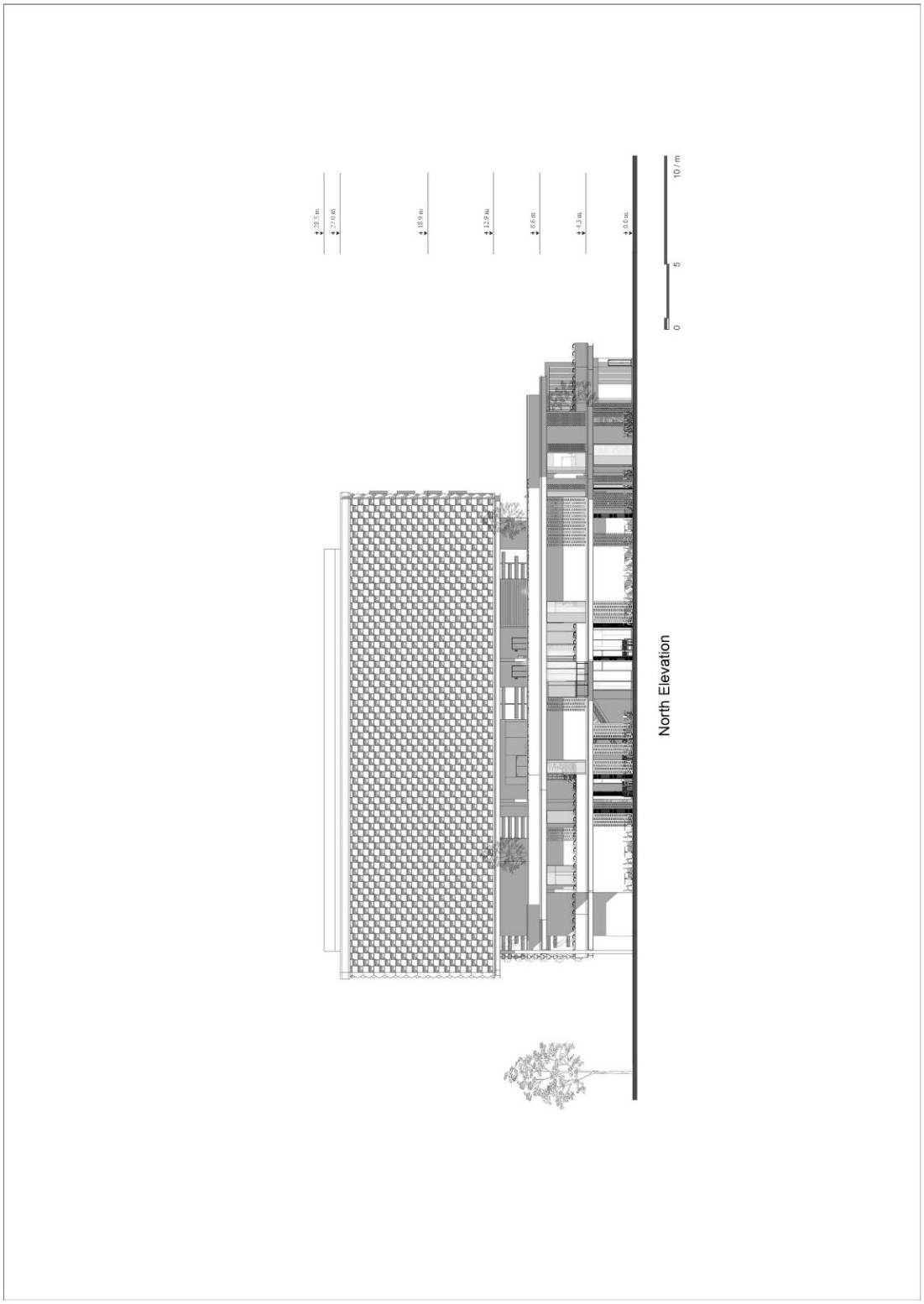


Figure 5. 39 North elevation

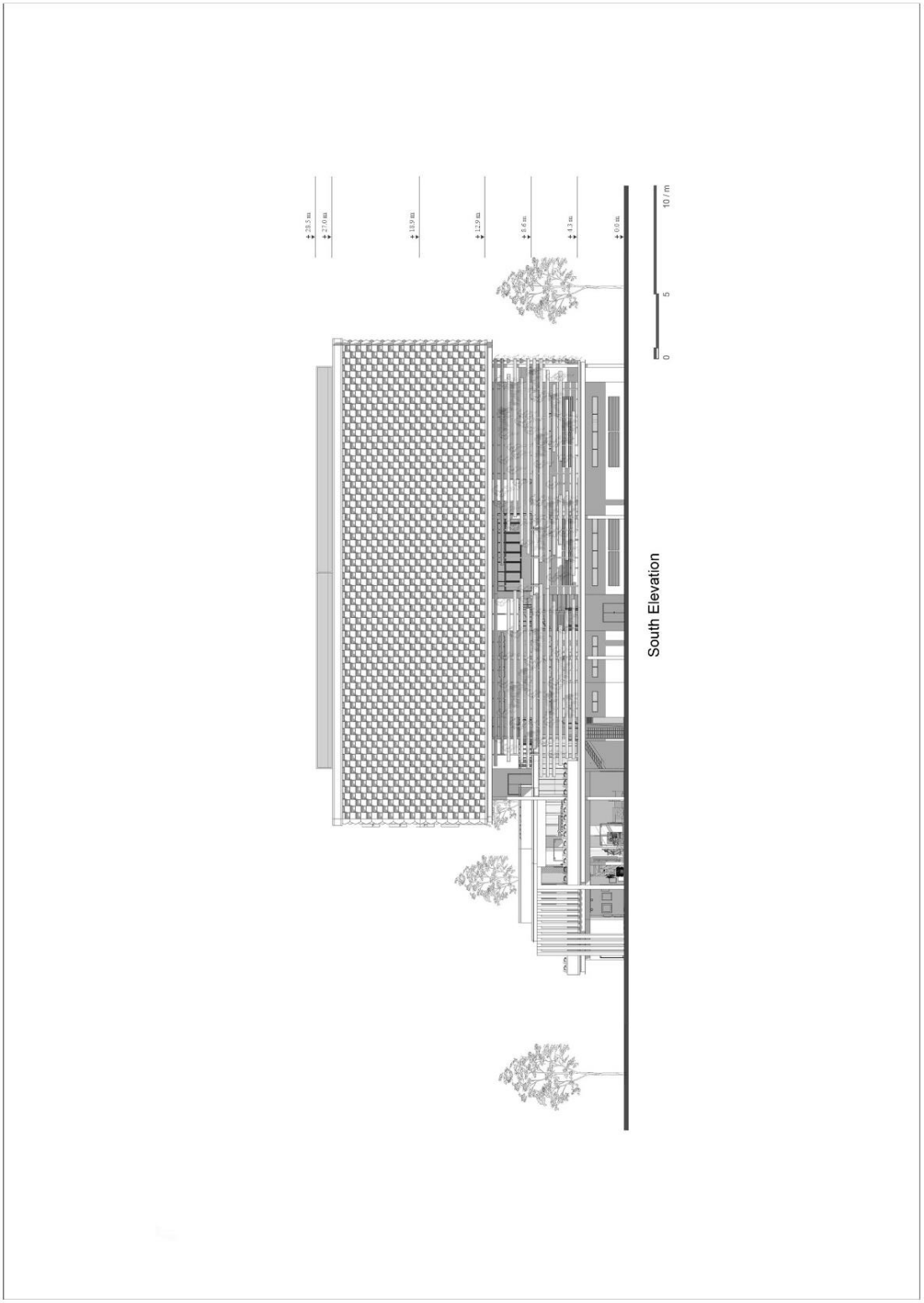


Figure 5. 40 South elevation

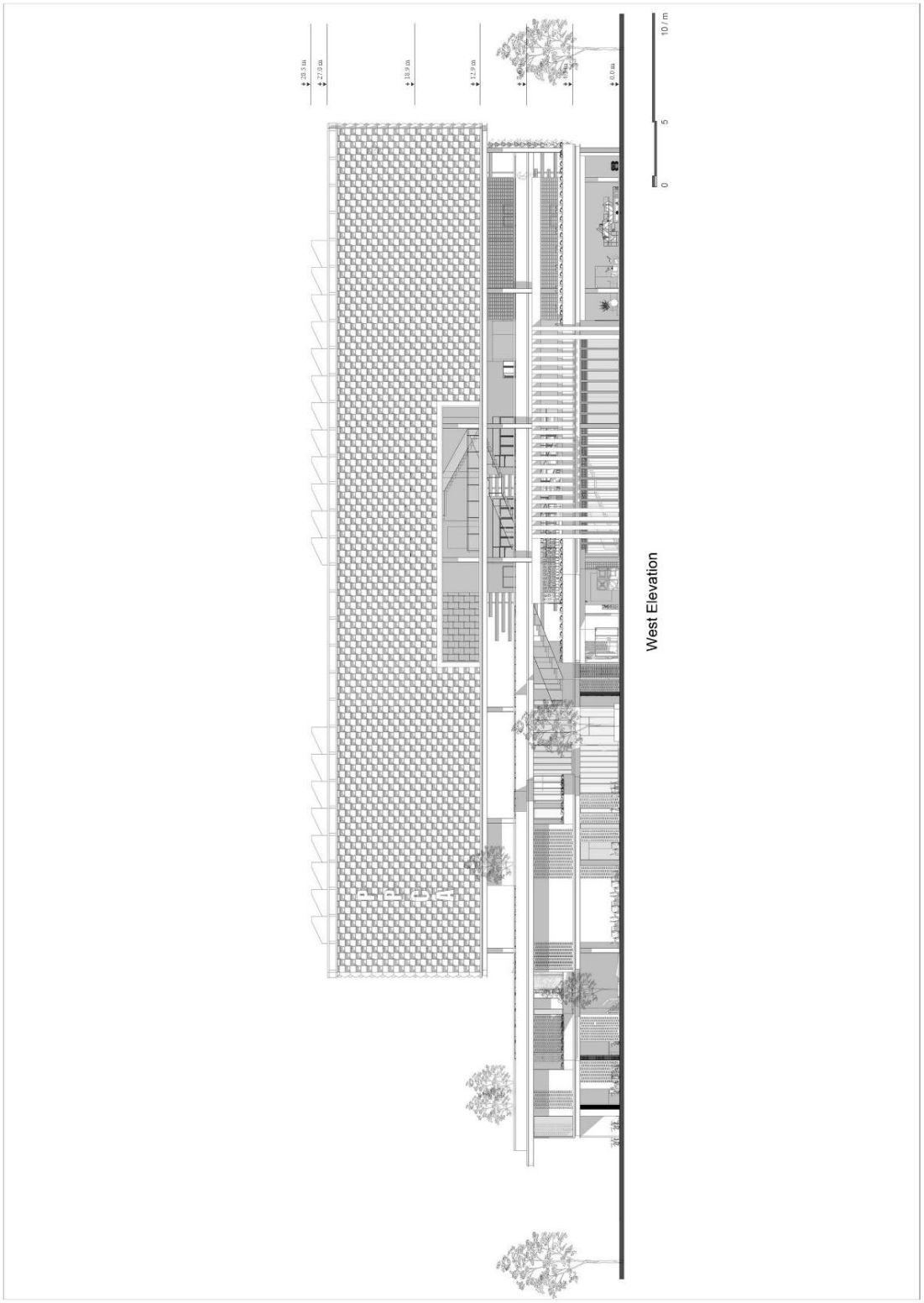


Figure 5. 41 West elevation

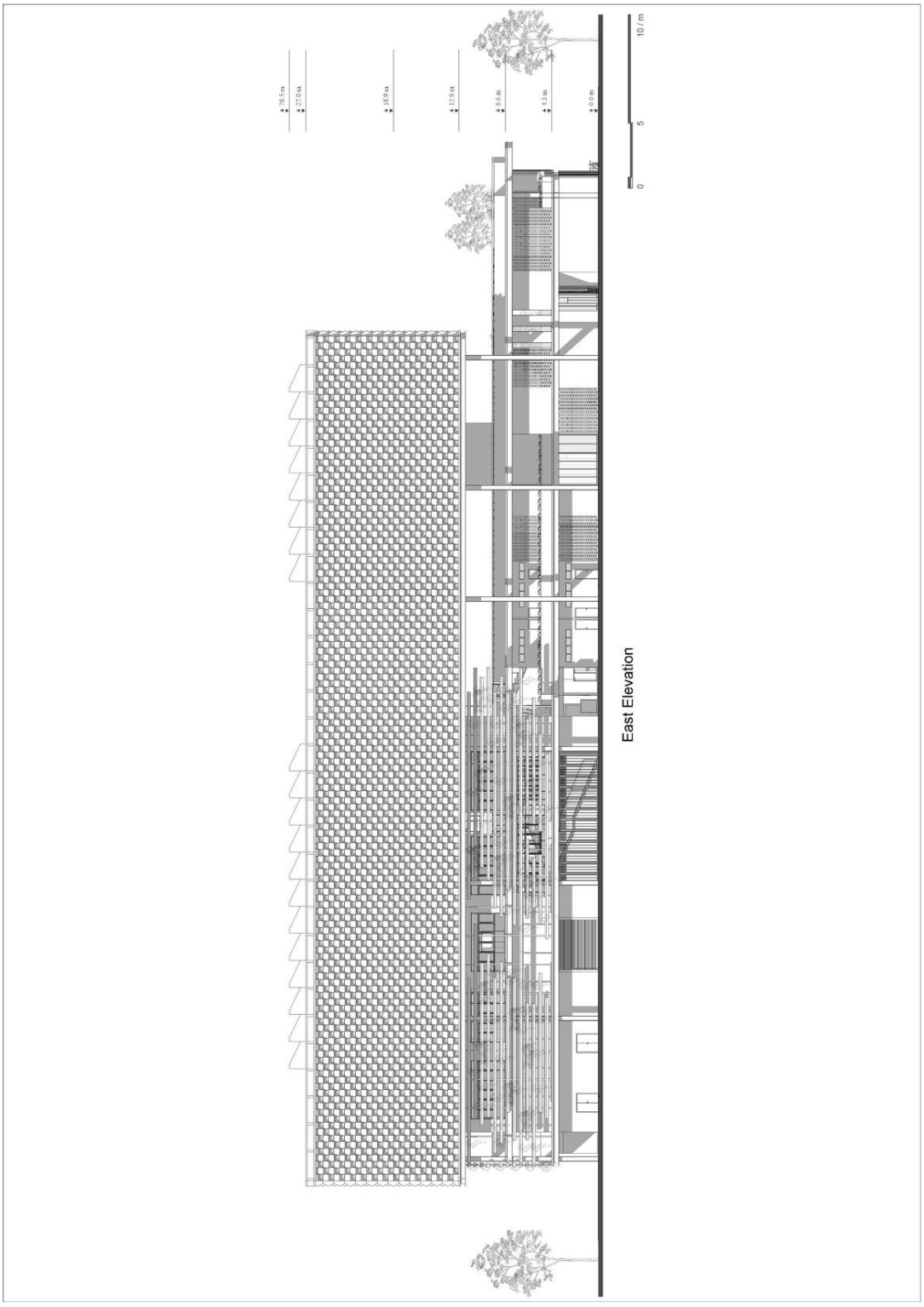


Figure 5. 42 East elevation

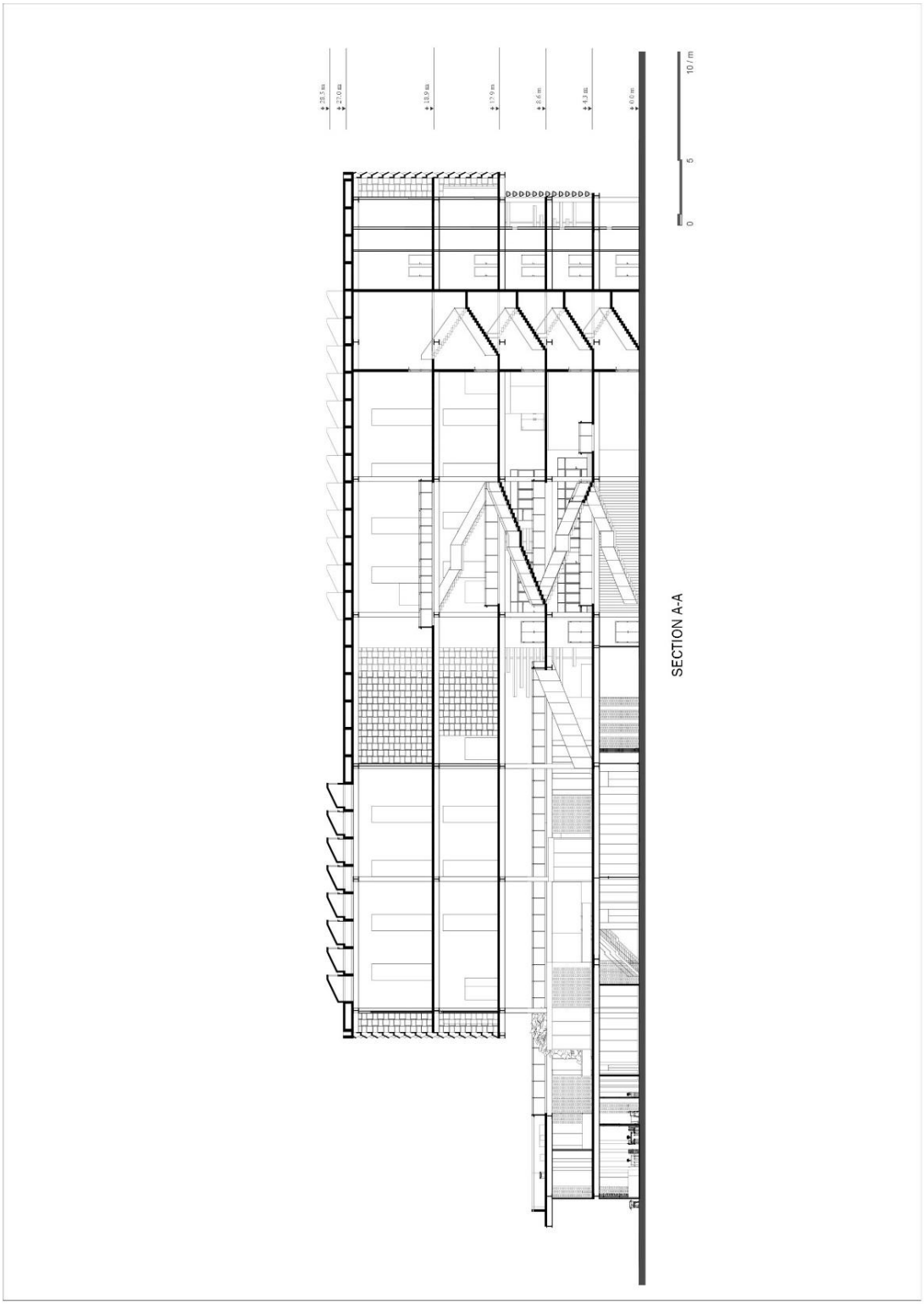


Figure 5. 43 Section A-A

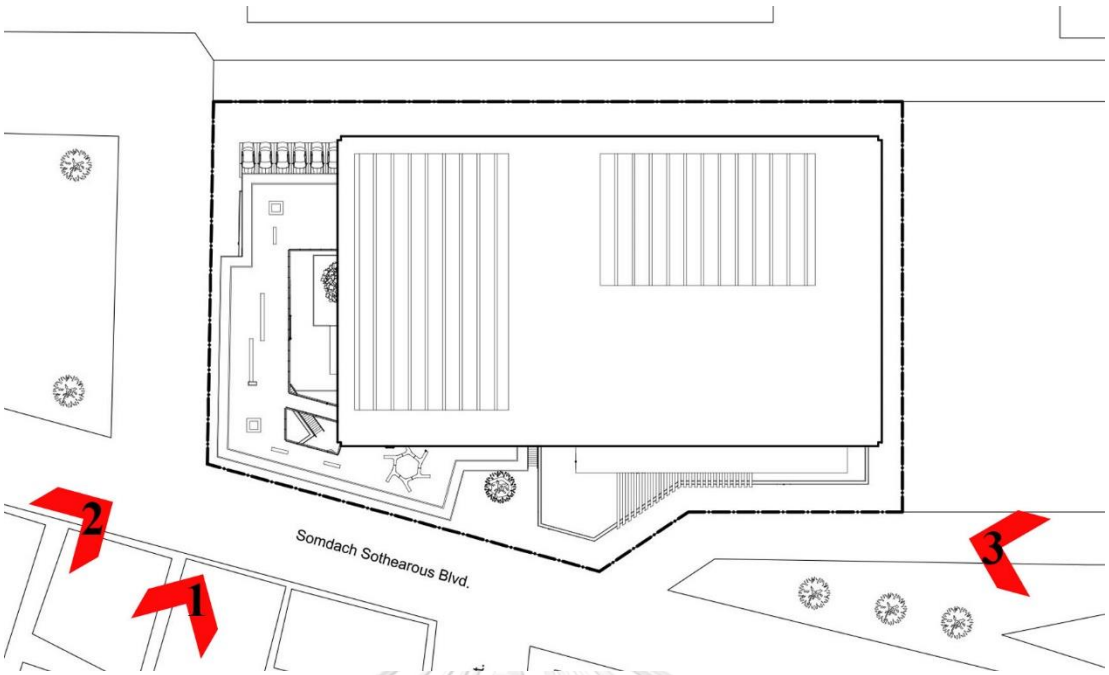


Figure 5. 44 Index plan of perspectives rendering.

Figure 5. 45 Perspective 1

Figure 5. 46 Perspective 2

Figure 5. 47 Perspective 3

Figure 5. 48 Photo of design model

Figure 5. 49 Photo of design model

Figure 5. 50 Photo of design model

Figure 5. 51 Photo of design model

CHAPTER 6 CONCLUSION

6.1 Summary of the Lessons from Van Molyvann

Vann Molyvann founded modern architecture in Cambodia. He worked at a time when technology was not adequately advanced. Therefore, his tactics involved analysis of the tropical climate to come up with counter-mechanisms that entailed modification of the buildings as summarized in the following paragraphs.

Water

Due to the high temperatures, it was imperative to enhance water management in the buildings. The convenient drainage systems were a mechanism for preventing floods during the wet season. In some buildings, shallow storage tanks were connected to the rooftops. Rainwater drained in the ponds had been collected and stored not only for future use but also to prevent flooding. Stilts were used for raising buildings to a certain height from the ground as a precautionary measure, in case of flooding, to avoid damage to the property. Water was also used for buildings cooling purposes during the hot seasons, particularly, for those with basement in which water was frozen to severing as a coolant to the floor of the building. This was enhanced by the water stored at the top of the building that vaporized when heat by the sun providing the more cooling effect. In extreme temperature seasons, the harbored water was directly released into the environment to increase humidity into the atmosphere.

Level off the Ground

Vann had his buildings raised from the ground primarily to prevent damage in case of flooding. At the same time, this provided space for activities such as parking, welding, and communal children play ground. However, the raised feature was also a mechanism to increase the exposure of the buildings to the cool monsoon winds, since there was a minimal distraction from natural phenomena such as trees and other buildings. This characteristic did not only facilitate circulation of air into the building

through ventilation located beneath the structures but also enhanced security since access to the buildings was limited to few entrance points.

Wall

Buildings designed by Vann had massive double walls, which ensured a balance of heat between the outside and inside of the building. The walls also ensured that heat from the outside, where the temperature was very high, was trapped between the walls since it did not have enough energy to go through the second wall. The temperature of the interior of the building remained relatively cool. In instances where Vann omitted the double wall, he perforated the single walls with holes, which were drilled to provide ventilation and lighting as well as avoiding external distractions. Windows were also used for the same purposes on several occasions, with the advantage of providing a view of the surrounding nature. The wall design was also used to shield the building from rain and during summer the walls provided cooling effect through evaporation of most of its constituents.

Roofing

A double roofing system ensured that heat from the sun and the surroundings was trapped between the roofs and the interior remained comparatively cold. Further, the buildings had flattened roof designed to allow airflow into the structure and leave through the peripheral openings. Additionally, the double walls prevented leakage to the interior. The roof was designed to collect rainwater and hold water into pond used for cooling purpose. The roofs had a vast space between them to prevent the outer roof from transmitting heat to the lower roof. In other cases, the inner roof was designed to be raised high above the floor of the building. The mechanism ensured that heat from the sun that managed to get past the two roofs lost its potency in the air between the lower roof and the floor; hence, it was cool enough when it reached the floor.

Shading

Vann Molyvann building achieved shading using the double walls serving as a shield against direct sunlight. More shading was provided by upper levels of the lower floor and vertical shade on the upper floor. Other structures were designed with deep weaves, which prevented entry of sun to the buildings. In addition, perforate wall with different kinds of design such as prefabricated ventilation block also provides shade and ventilation at the same time into the internal space of the building.

Program and Orientation

All Vann Molyvann's building had specific design meant to deal with tropical climate. In particular, his architectural methods took into account the direction of the sun and wind to manage cold and heat creating comfortable environments in the interiors of the structure. At the same time, Vann designed his building in a way that allowed good air circulation despite the harsh tropical climate either by incorporating separated pendulous roofs, curved veranda, narrow or operable windows. The location of the building was also an important factor with most structure facing north-south direction to provide proper ventilation. These provisions allowed the creation of calm environment facilitated by aesthetic nature of the buildings.

Other findings

Vann's buildings were mostly made of brick, not only because it blends beautifully with tropical nature, but also because bricks regulate humidity. Bricks are porous, hence they absorb water vapor from the environment. When humidity is low, bricks release the water vapor in the form of water, hence ensuring the room remains warm. Vann took advantage of this aspect, besides the fact that with bricks, architects can design buildings using an endless variety of possibilities. The use of bricks also ensured that the buildings were stable and intact due to the adequate laps between joints from one brick to another. The stability protected the buildings from adverse weather conditions such as heavy winds and storms.

6.2 Conclusions from the Research

From the research, it is evident that Vann's techniques were productive in solving climate-related issues on buildings. He did this despite the little advancement in technology and with limited resources regarding exposure to research. In the current modern society, application of Vann's ideas blended with technology would produce incredibly viable results. Buildings constructed as a result of the incorporation of both ideas will be responsive to the needs of current society, since the requirements that served the needs of the past have now become obsolete. However, it is important to note that Vann's method can be used in areas where monetary resources are few; hence, installing air-conditioners is a hassle. Vann's ideas should be developed to address the current architectural needs such as limited space for building or expansion, global warming, and lack of creativity among architects.

Vann's blueprints are important approaches to dealing with the tropical climate in Cambodia. Vann's understood the connection of weather and architectural disasters such as buildings were raised to specific height above the ground to prevent flooding. Of more significance are natural air ventilation and reduction of direct sunlight to the buildings, the orientation of the building in relation to the sun and wind direction provide better comfort and sustainability despite the hard condition of the tropical climate. The building either faced north-south or east-west based on the location of the building to create serene living environment. For instance, walls with double layers on the eastern and western side and skylight facing the north-south direction on roofs to allow sufficient ventilation. Also, the uniqueness of prefabricate part such as walls exhibited their robustness despite the tropical weather conditions. However, some of the elements such as double roofing and double wall system also poses some challenges that include difficulty in cleaning the space in between the double layer structures, within the small spaces rendering the trapped dust and substances inaccessible. Despite that, the only thing that is one noteworthy challenge presented by the pool. It requires a lot of expenses to clean and undertake routine maintenance. Whereas, to achieve the passive cooling underground pool is needed for a bigger space

to hold more water, this indicate that vital of space was depleted which is not suitable for a small building.

Moreover, it is also important to note that there were other tropical architectural designs that had incorporated Vann's strategies prior to the existence of the buildings. However, Vann's approaches were conducted through modern designing languages, which were an application of the non-tropical areas. This made the languages used by Vann draw the attention of architectural studies. Since they were used as points of reference for contemporary architecture to practice better and feasible blueprints for the country.

Importance of Vann's Discoveries

Vann inspired a new wave of creativity in the field of architecture. Vann was the first architect to blend ancient architecture of Cambodia with austere modern architecture to come up with signature building designs. This was a remarkable inspiration both to upcoming and existing architects, who have since used the idea to come up with buildings all over the world.

Due to the little advancement in technology in the 1960s, Vann designed methods to counter climatic difficulties. To date, his methods are still adopted in areas with tropical climates. The natural methods are especially significant to the conditions that cannot afford advanced technology such as air-conditioners.

Moreover, based on the analysis conducted in this study, it is evident that Vann Molyvann strategies can be adopted in the future design of contemporary Cambodia Architecture and more. In particular, the fundamental benefit of Vann Molyvann architectural styles is that the designs are ecologically sustainable. Vann Molyvann buildings have provided numerous examples of how traditional techniques can be used to locate buildings in the environment, obviating the need to consider traditional architectural styles building process and natural landscapes in contemporary Cambodia. Human beings have been degrading the environment and sustainable designing of the new technology being used to develop buildings that are self-reliant. Environmentally, the designs can be used to prevent natural disasters such as flooding. The Vann Molyvann buildings had a considerable social impact in terms of human

health, security, and safety, satisfaction, comfort, and well-being. Additionally, although most of the buildings today are considerably large, the modern development process is not cost effective or environmentally sustainable. Therefore, the strategies used by Vann Molyvann could be utilized in modern buildings to create energy sustainable structures.

6.3 Application of the research in proposed design

The aim of the study is not to oppose the use of air-conditioning, but rather to find a way that we can moderate the expense of energy efficiency for new architecture. The proposed design is a contemporary art space in Cambodia, which is the ideal location since it has a tropical climate similar to the climatic conditions that Vann worked on.

The design applies strategies from the research on Vann Molyvann's buildings, the use of water, level off the ground, wall, roofing, shading, program and orientation. However, air-conditioners are expensive to install. Moreover, once installed, air-conditioning systems consume a considerable amount of energy and cost. Consequently, they are inconvenient to contemporary non-commercial public buildings who cannot afford to pay the electricity bills due to little funding. The design hopes to offer an alternative solution for the condition. Vann's strategies are very substantial references for the contemporary architecture in Cambodia and the other similar climate condition.

6.4 Limitations of the study

One of the most significant limitations experienced in the study was inadequate resources on the works of Vann Molyvann, since some of the buildings had been repeatedly renovated some were demolished. It was difficult to accurately decipher the original design, image, and condition of the buildings. Moreover, Vann Molyvann lost almost all of his designed building documents during the Khmer Rouge, the Genocide Regime of 1976–1979. It was equally strenuous to redraw the plan layout of the buildings by simply reading the available articles.

Secondly, time for the research was limited. Given more time, I would have made the study more robust and intense. Especially on field observations and hold interviews with more architects who existed during the 1960s and had direct contact with Vann's buildings. Therefore, there would be more resources to cite from and refer to, which would render the research more successful.

Finally, Vann was appointed by the government of his time to modernize Cambodia. Therefore, most of his projects worked on government buildings. Access to the buildings for further research was limited. Furthermore, some of Vann's projects are privately owned and access to those buildings was also denied. The rejection restrained the close observation and study of his works.

6.5 Suggestions for future study

Whereas the study was limited to the masterpiece works of Vann due to his excellent performance, it is imperative to note that there are other architects in the similar period of the region whose designs also respond to tropical climatic conditions. It is necessary to consider reviewing the designs made by these other architects of the same period before the invention of modern cooling mechanisms such as the air-conditioner. The results of such research will be vast and more knowledgeable. And finally, they would lead to a better sustainable approach in architectural design of tropical climate.

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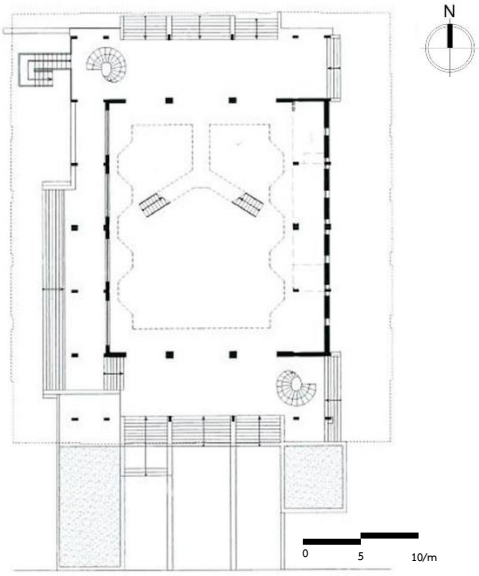
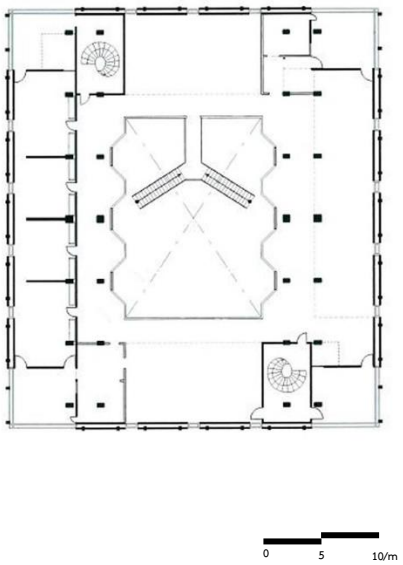
APPENDIX

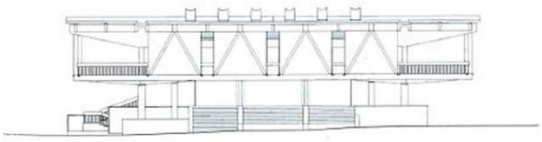
Appendix A: SKD Brewery



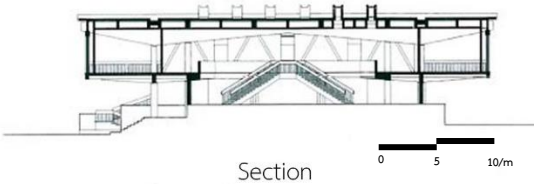
Grounf floor plan



First floor plan

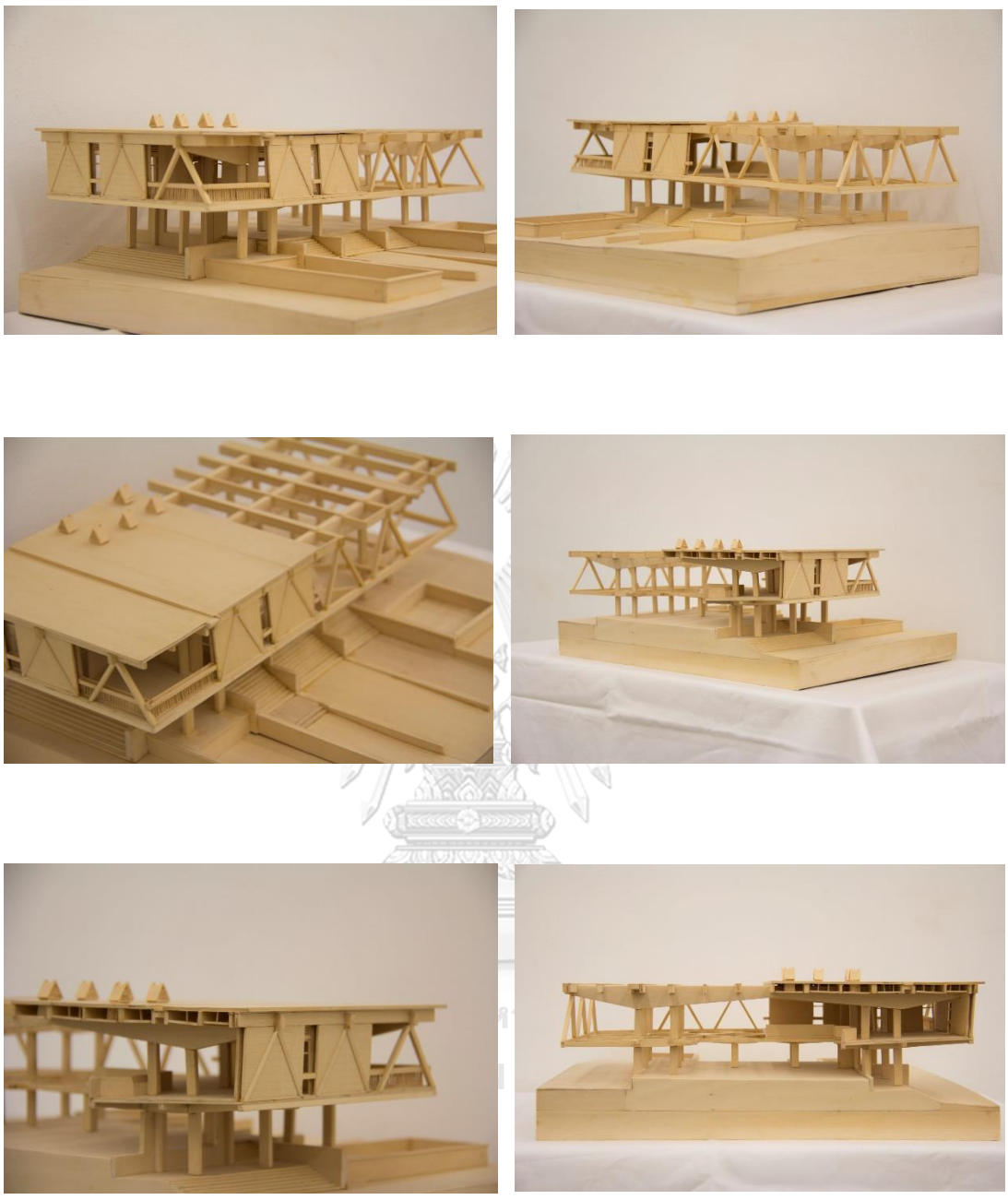


South Elevation



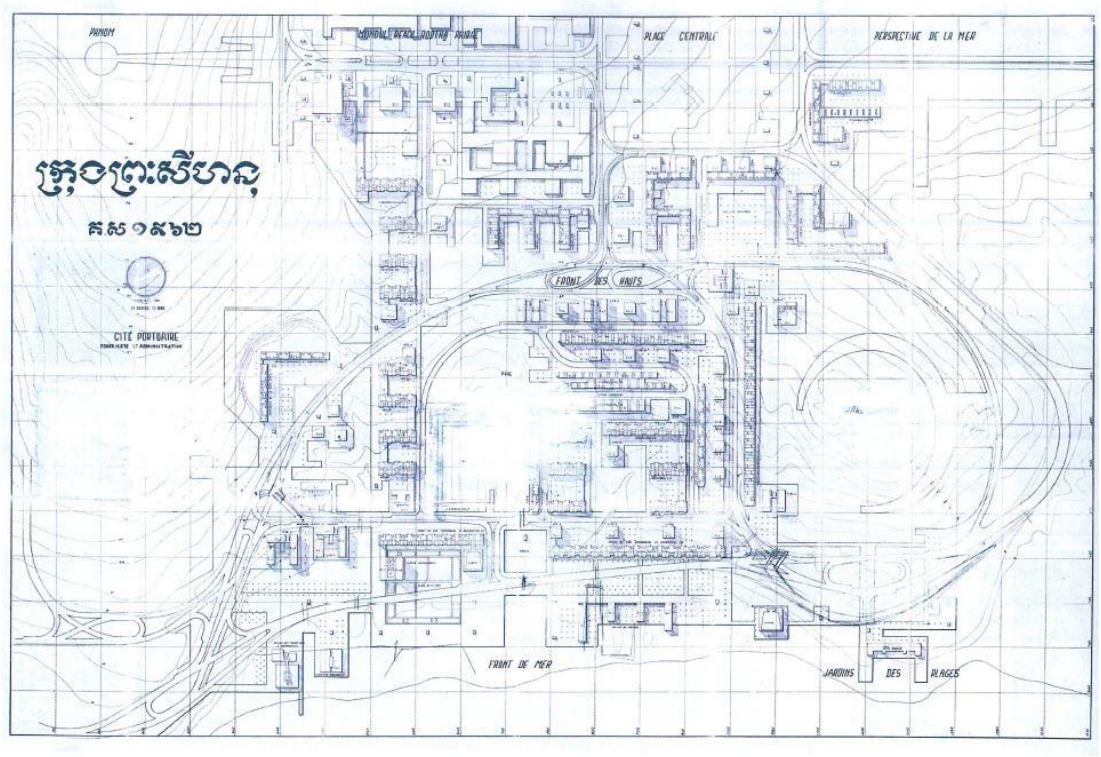
Section

Bird eye view from the east: Masterplan of the factory site (source: A+U Magazine)



SKD Brewery physical model (source: Vann Molyvann Project)

Appendix B: The central Bank Branch in Sihanoukville

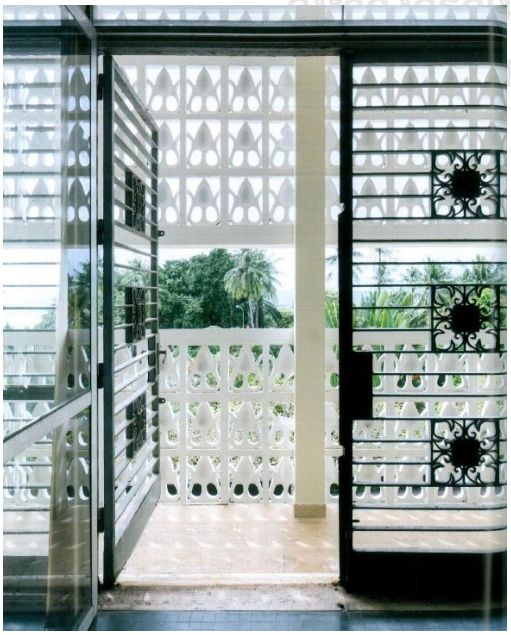


Masterplan in Sihanoukville, 1961. The proposed site for the bank is located on the lower left-hand corner of the drawing (source: A+U Magazine)

Aerial view of the site (source: A+U Magazine)

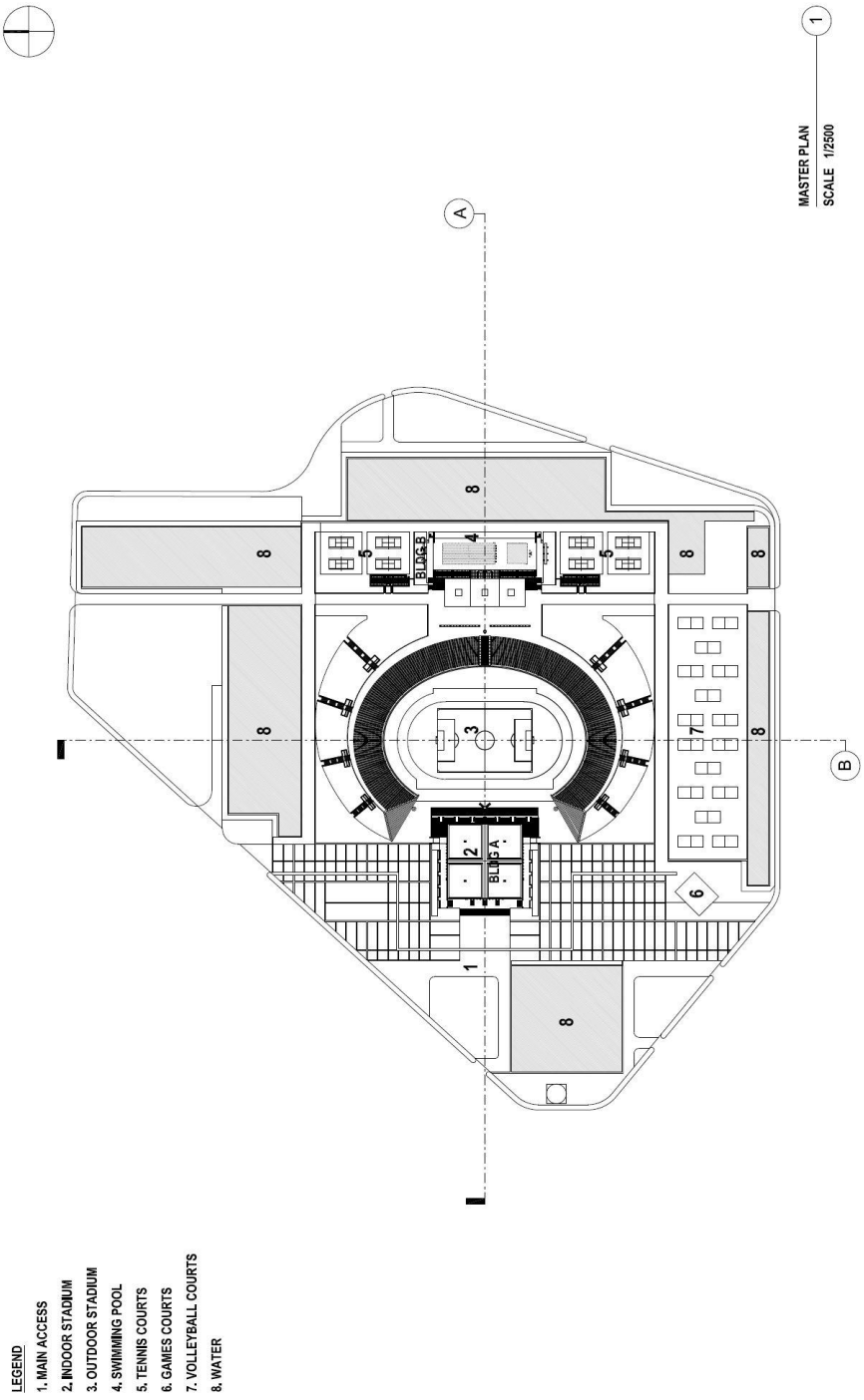
Bird's eye view from the northeast (source: A+U Magazine)

Interior view of the main hall (source: A+U Magazine)

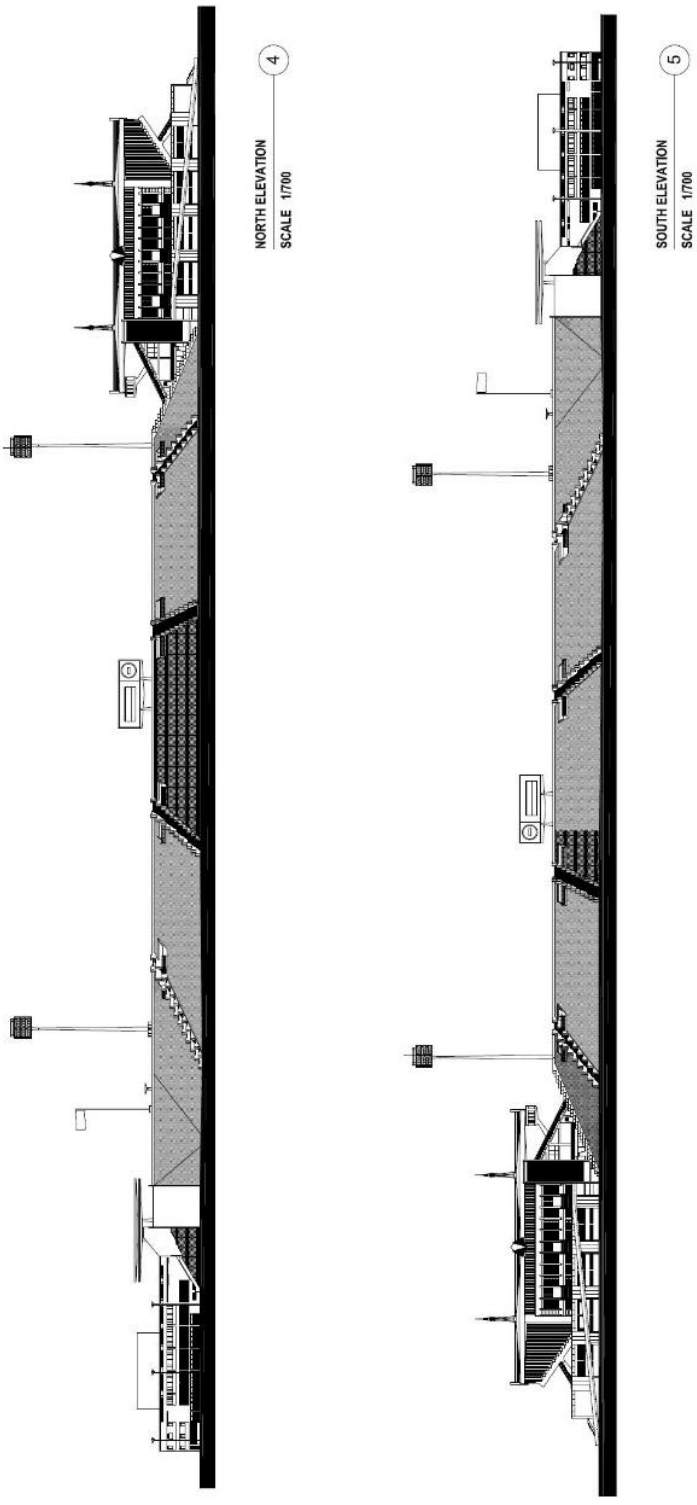


Opening of the westside of the main hall with a layer of iron lattice and perforated wall (source: A+U Magazine)

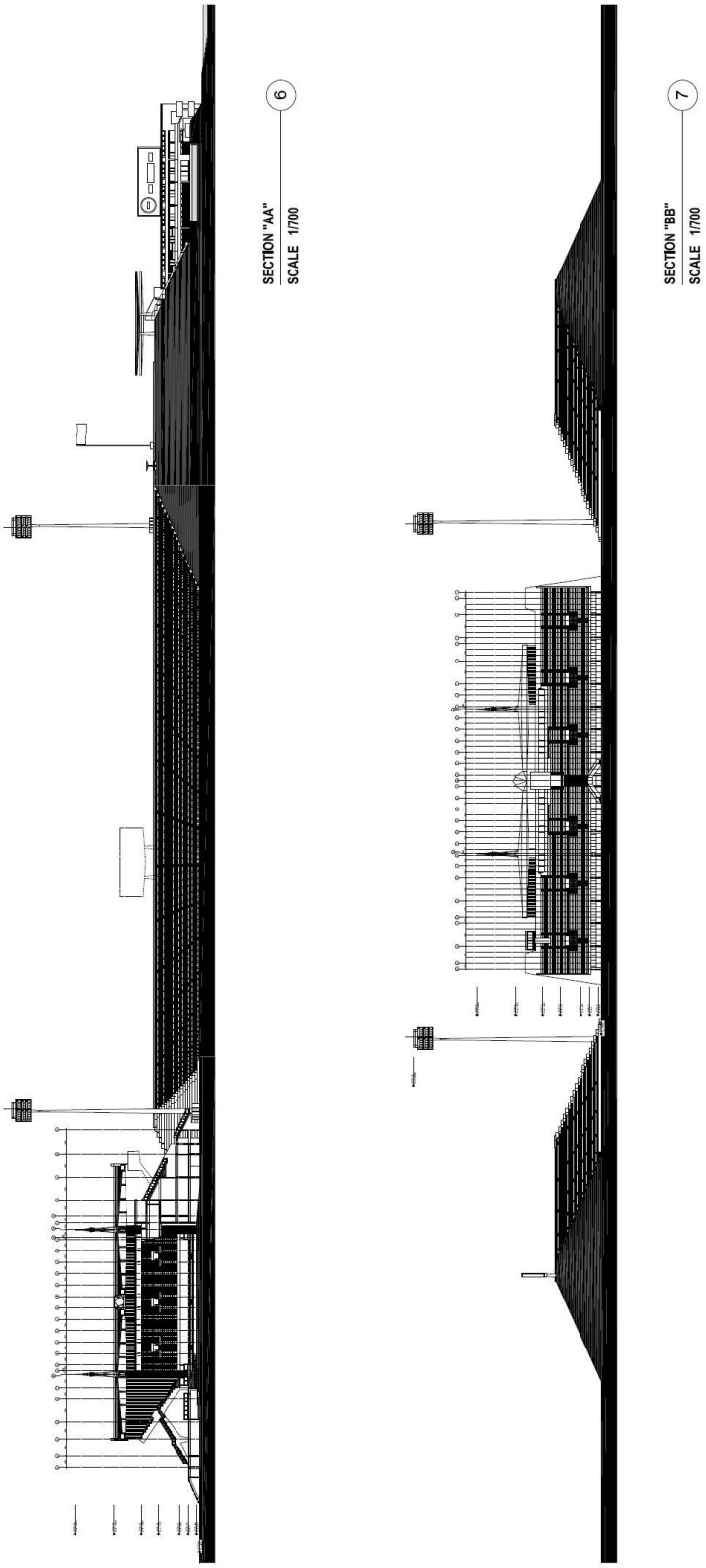
Appendix C: The National Sport Complex



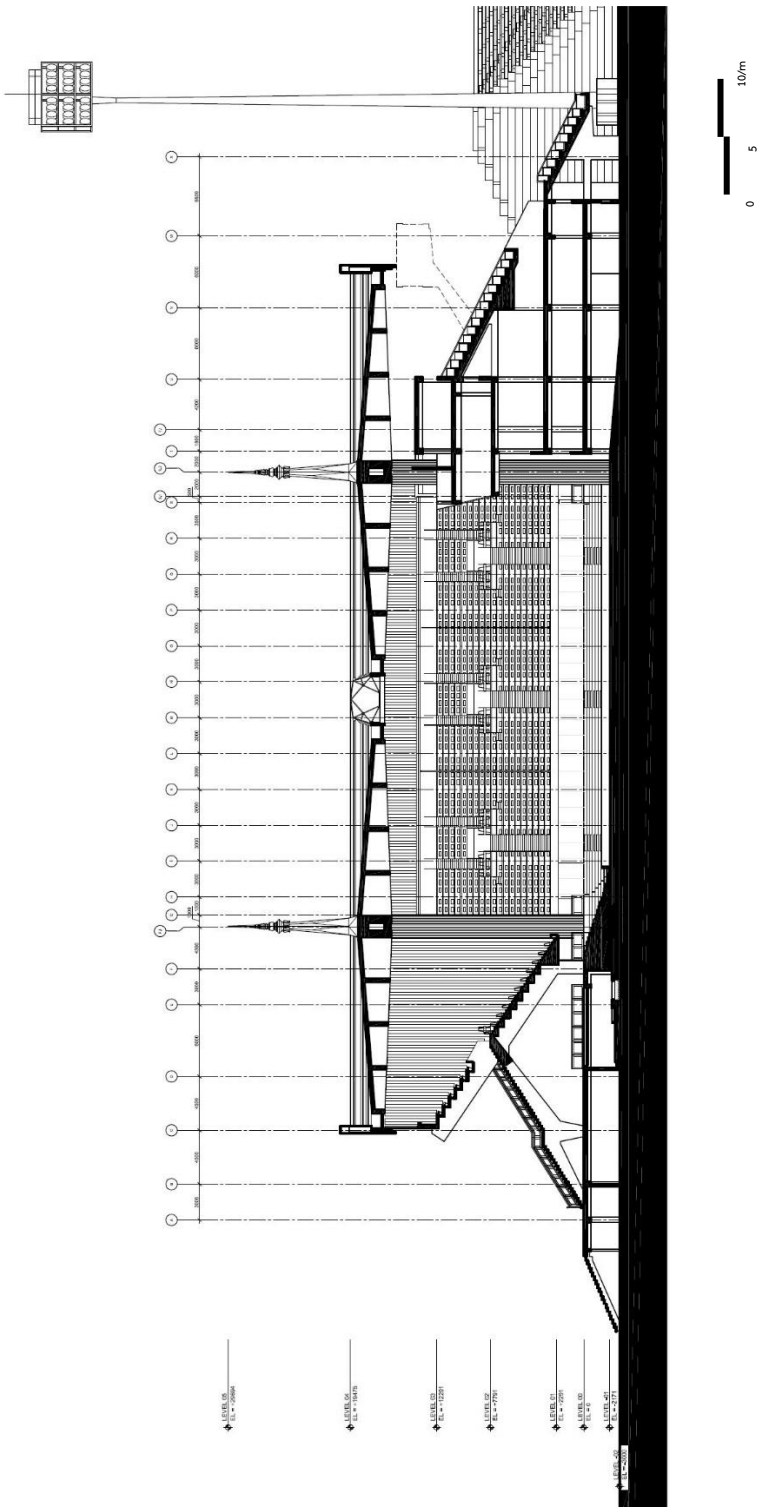
The National Sport Complex masterplan (source: Vann Molyvann Project)



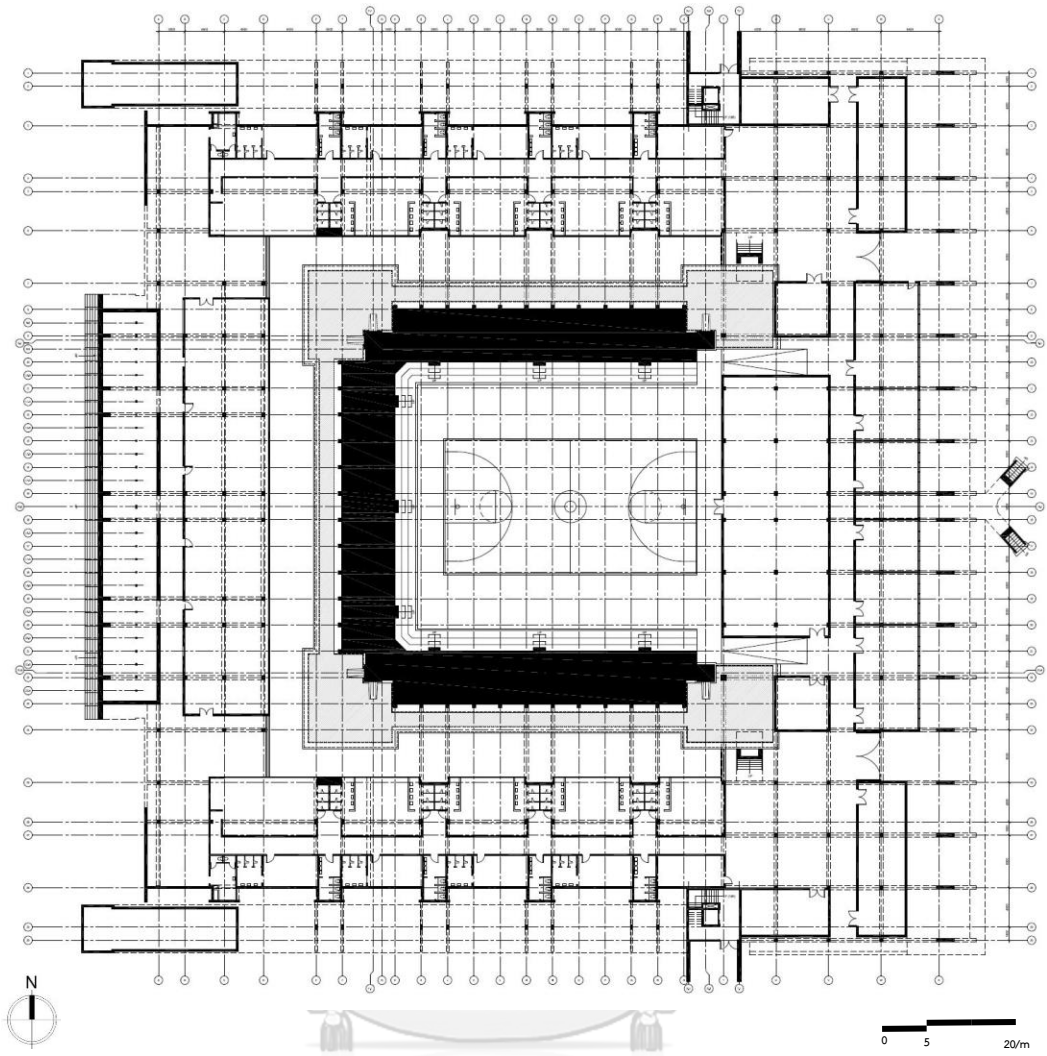
Elevation drawing (source: Vann Molyvann Project)



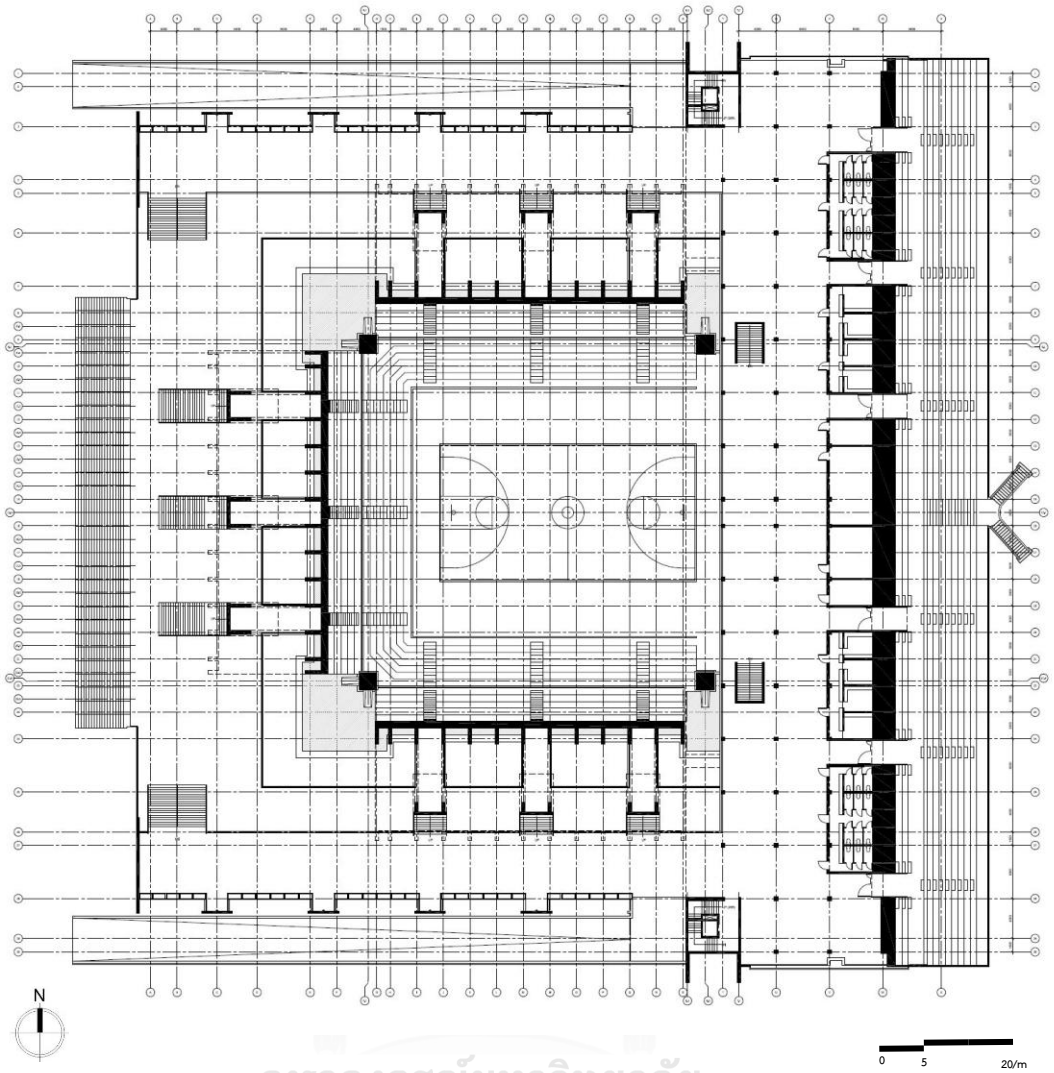
Section drawing (source: Vann Molyvann Project)



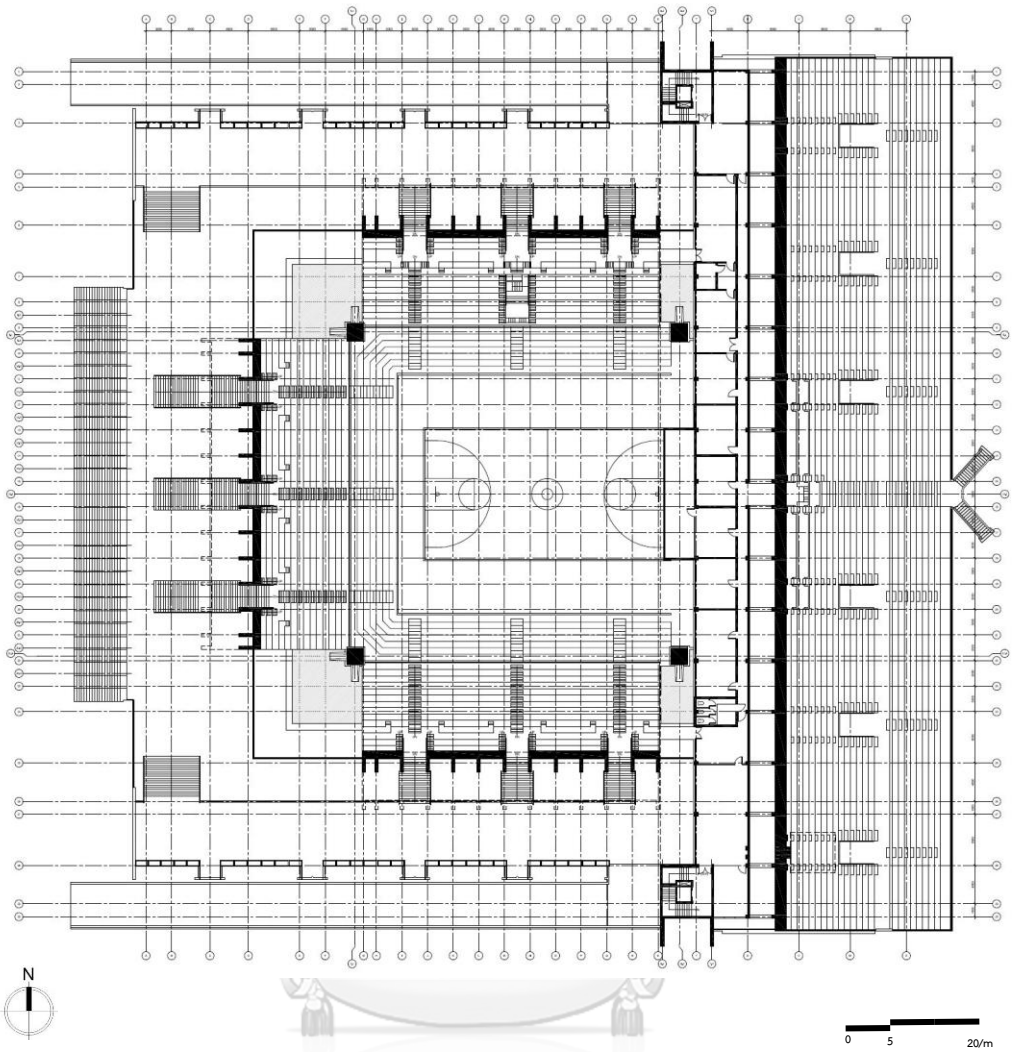
Section detail (source: Vann Molyvann Project)



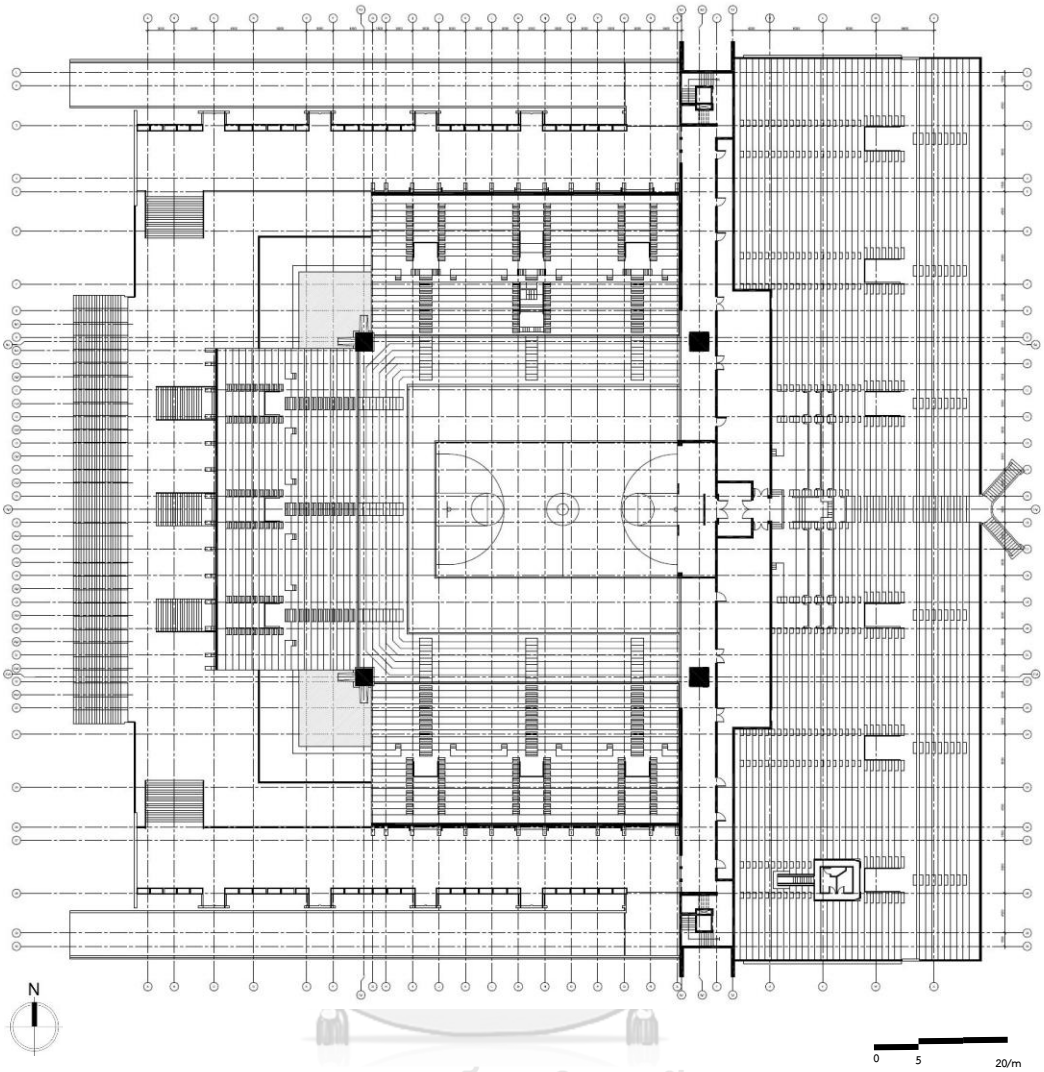
Ground floor plan (source: Vann Molyvann Project)



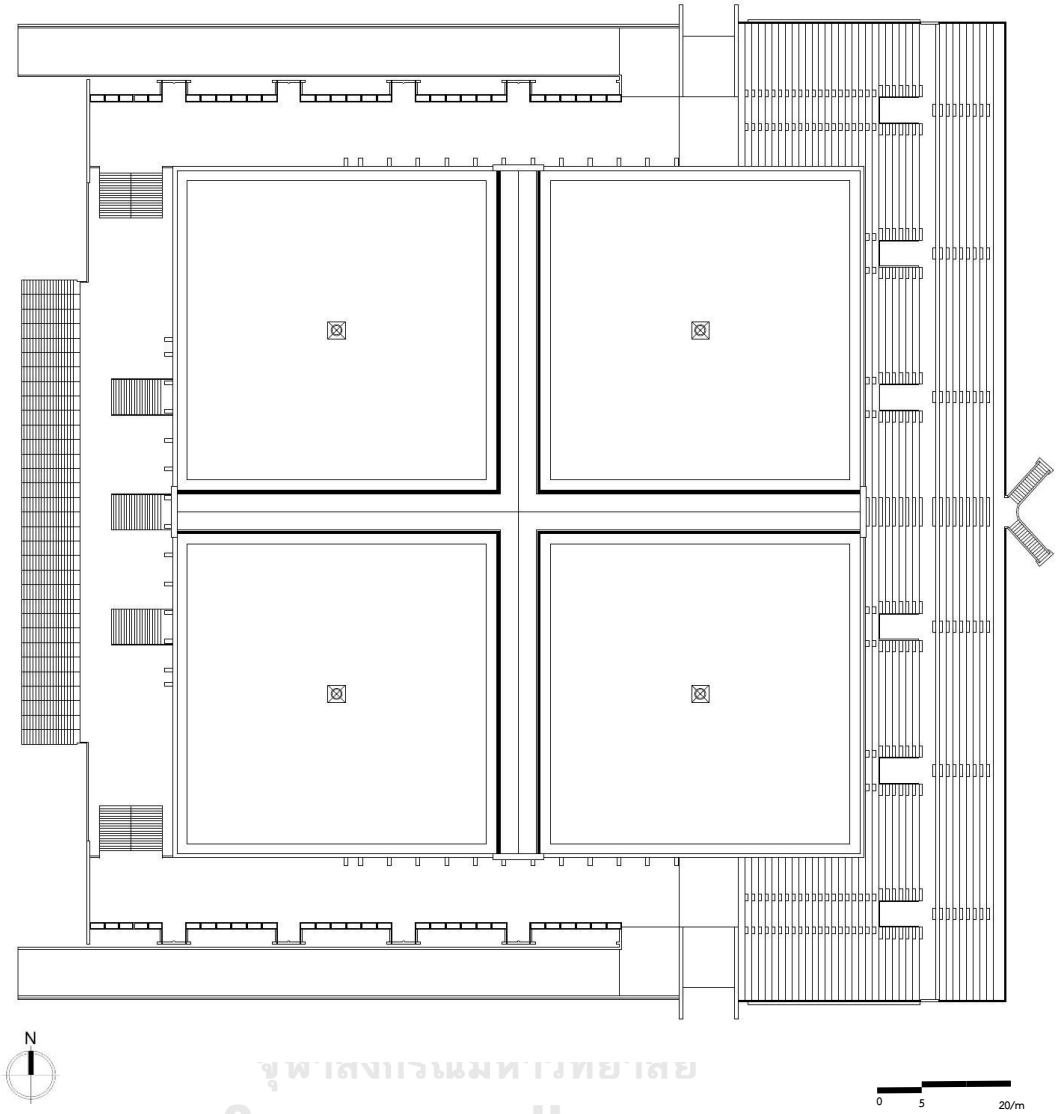
Second floor plan (source: Vann Molyvann Project)



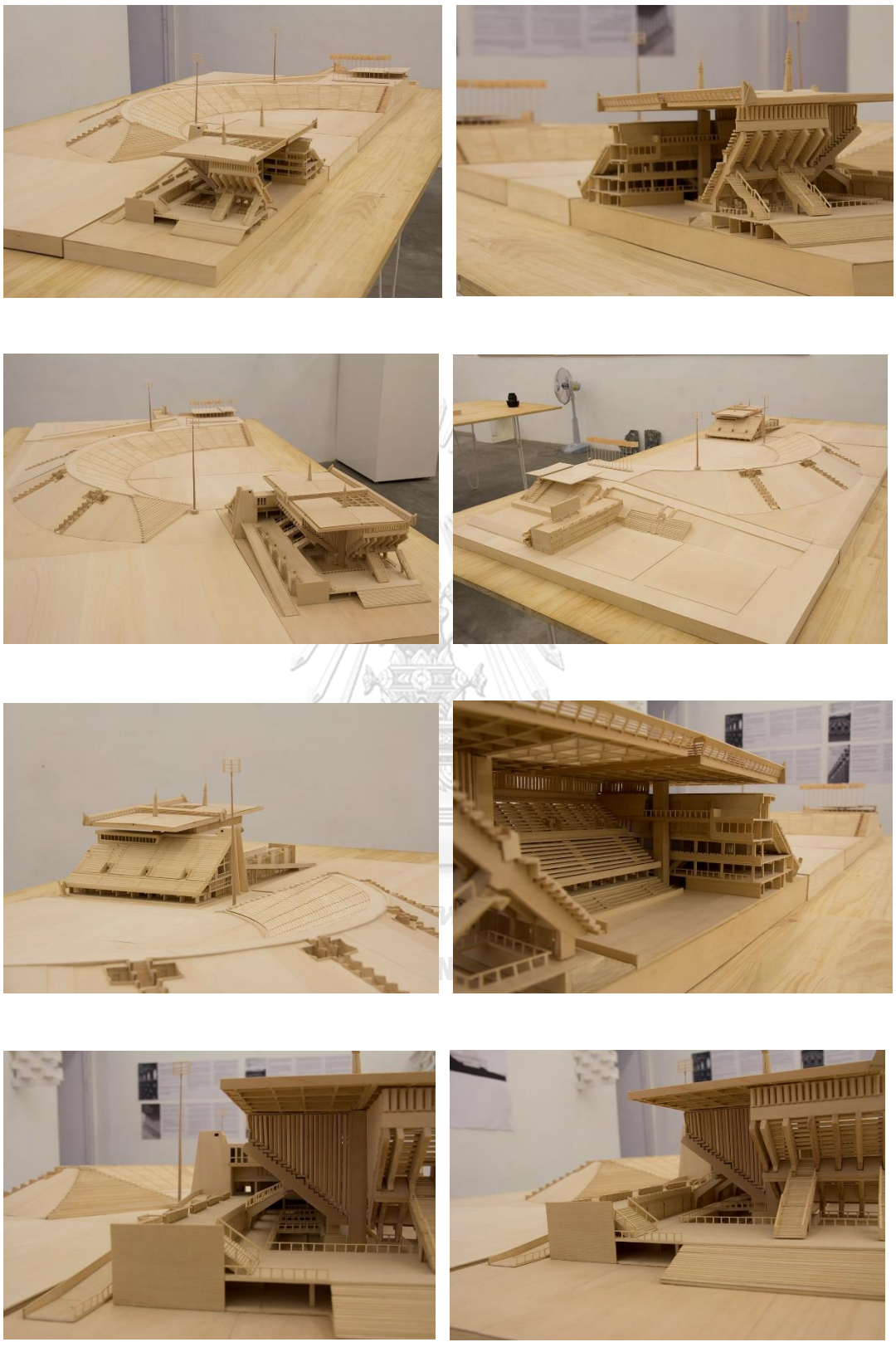
Third floor plan (source: Vann Molyvann Project)



Fourth floor plan (source: Vann Molyvann Project)

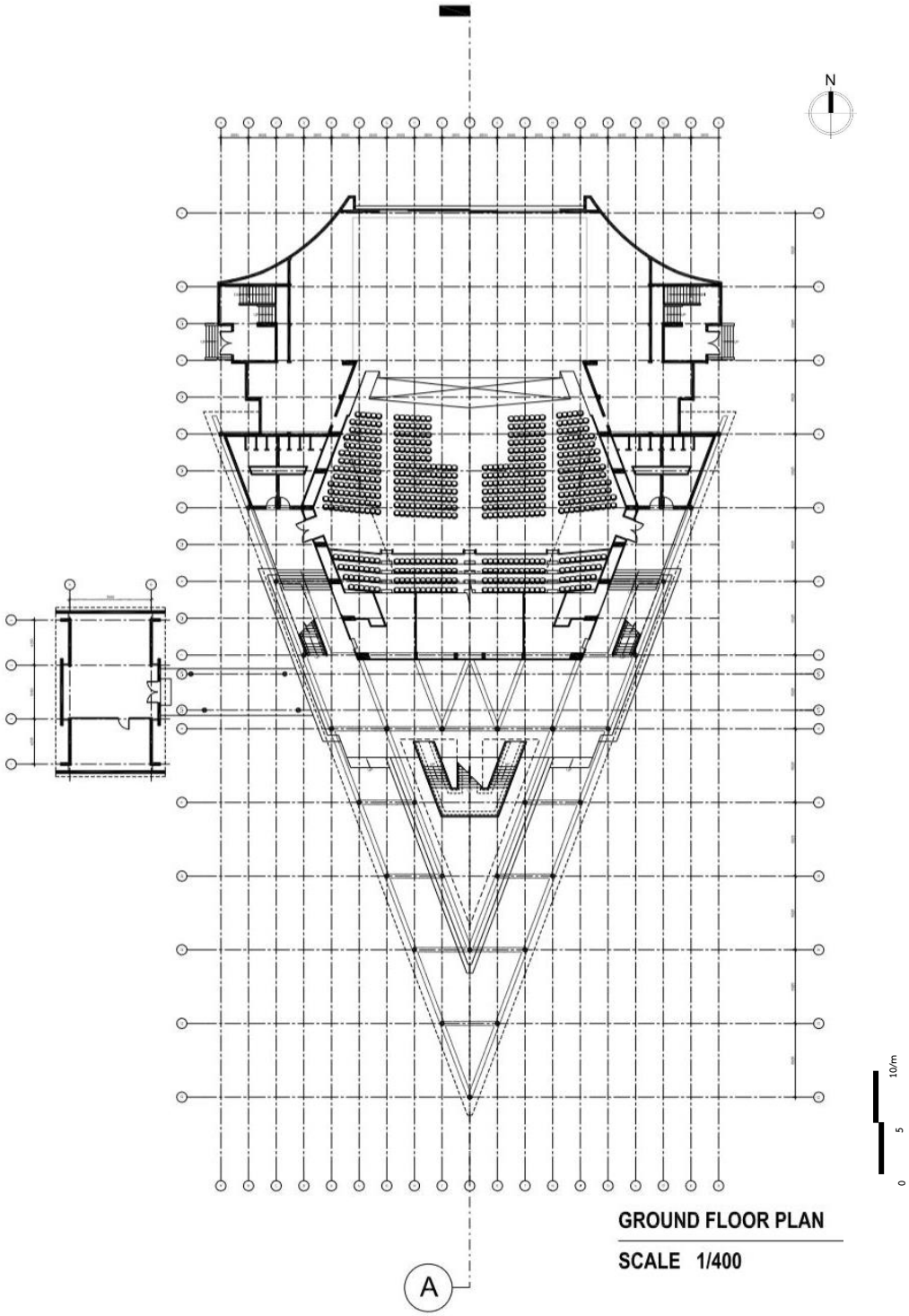


Roof floor plan (source: Vann Molyvann Project)

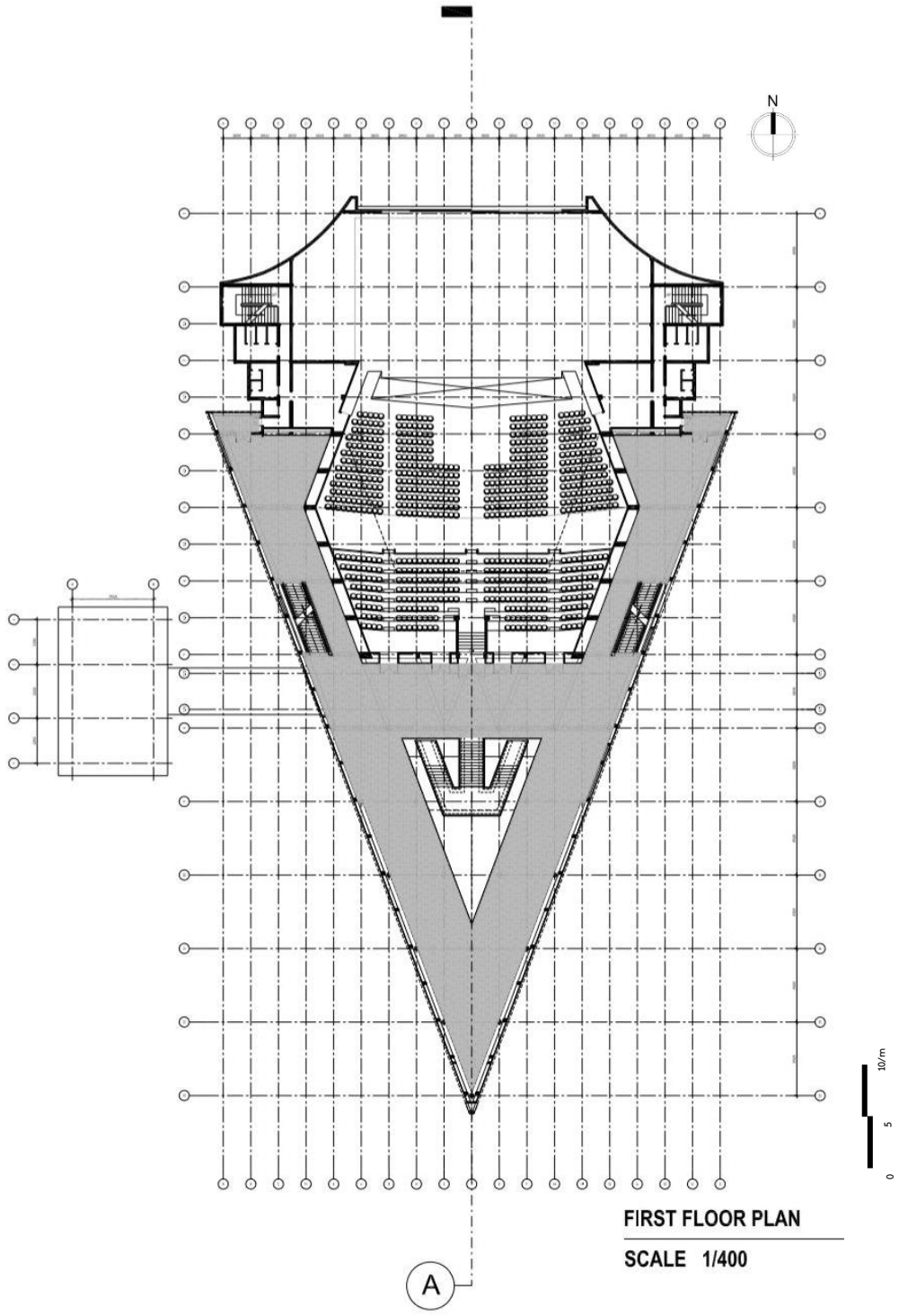


National Sport Complex physical model (source: Vann Molyvann Project)

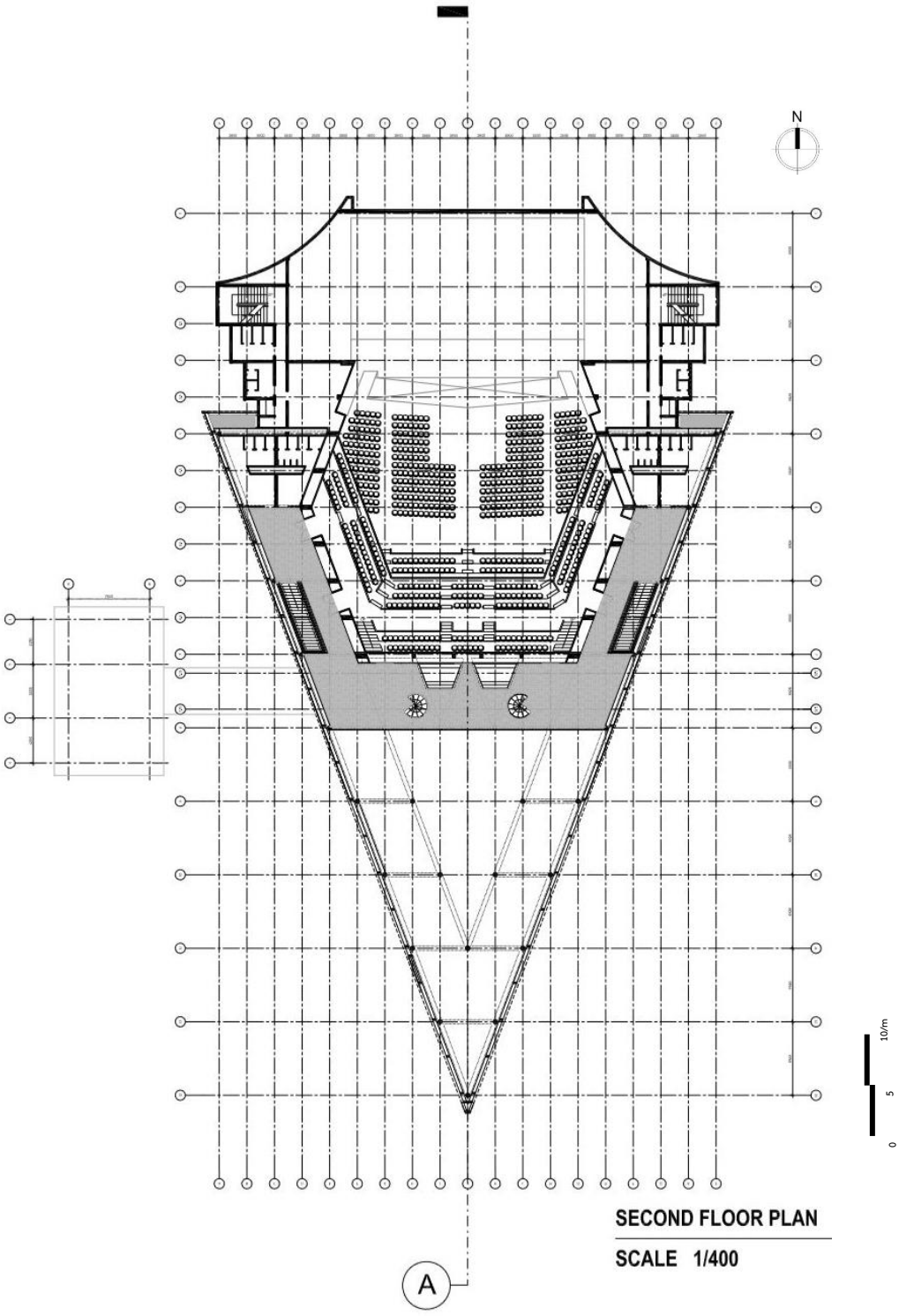
Appendix D: Preah Suramrit National Theatre



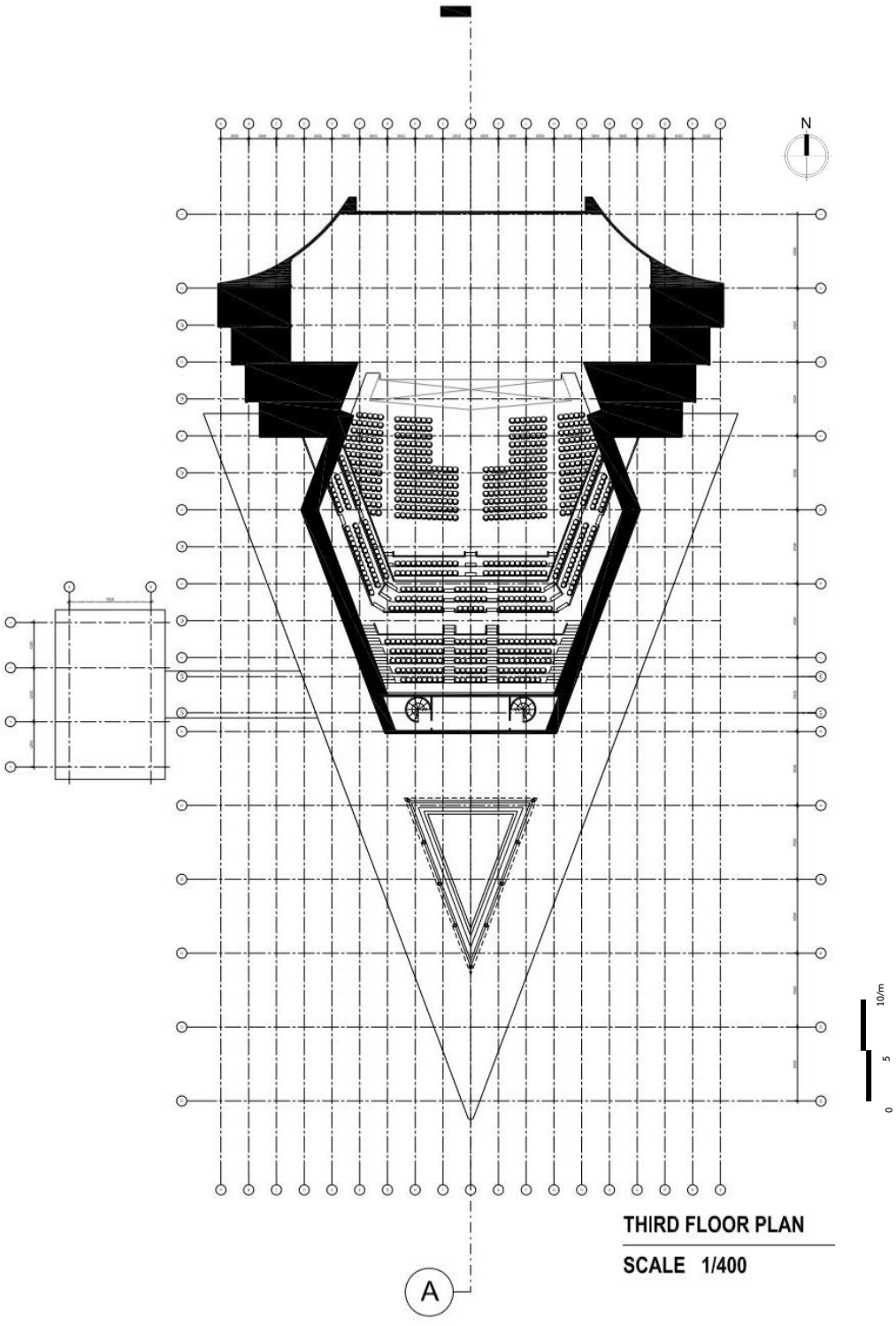
Ground plan (source: Vann Molyvann Project)



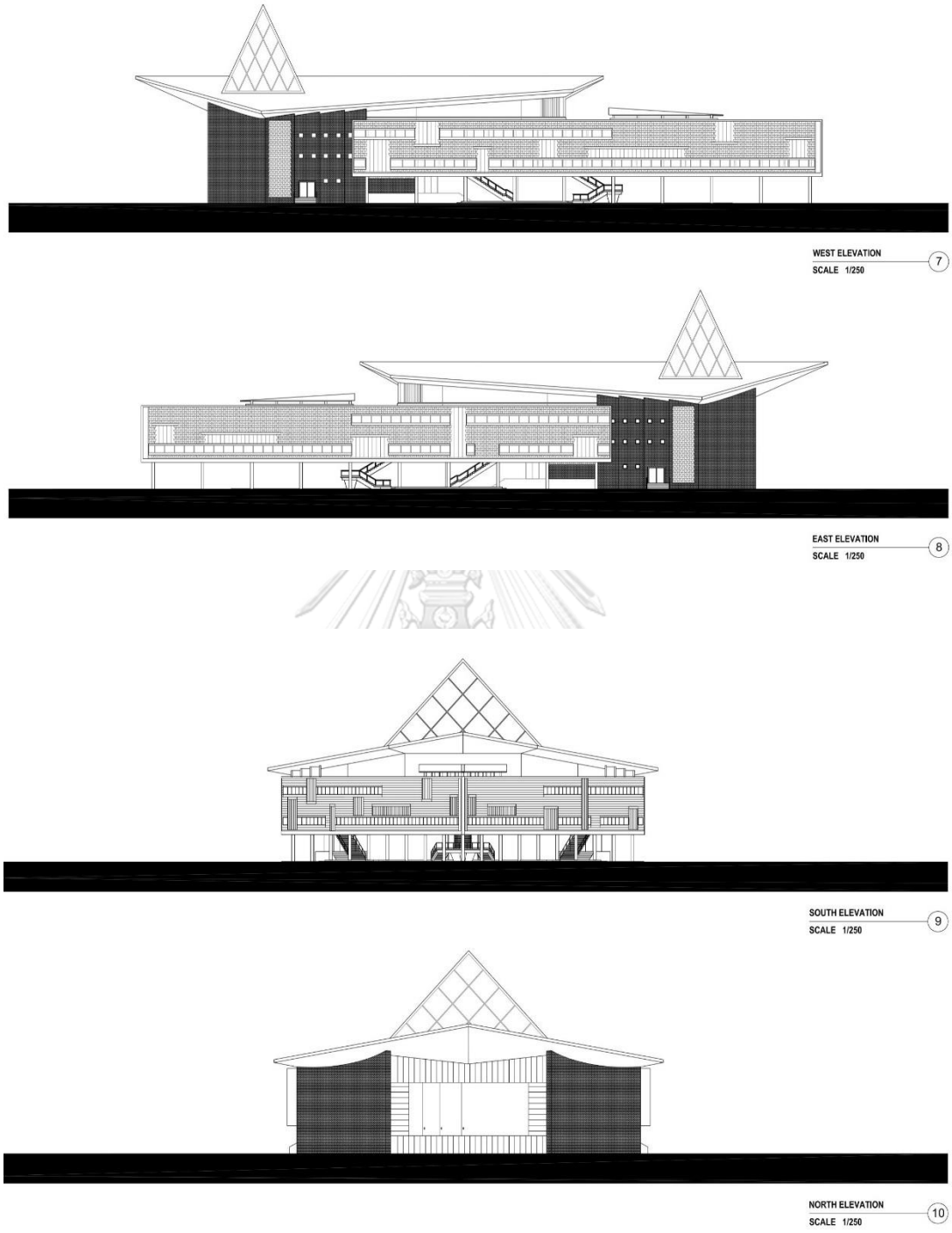
First floor plan (source: Vann Molyvann Project)



Second floor plan (source: Vann Molyvann Project)



Third floor plan (source: Vann Molyvann Project)

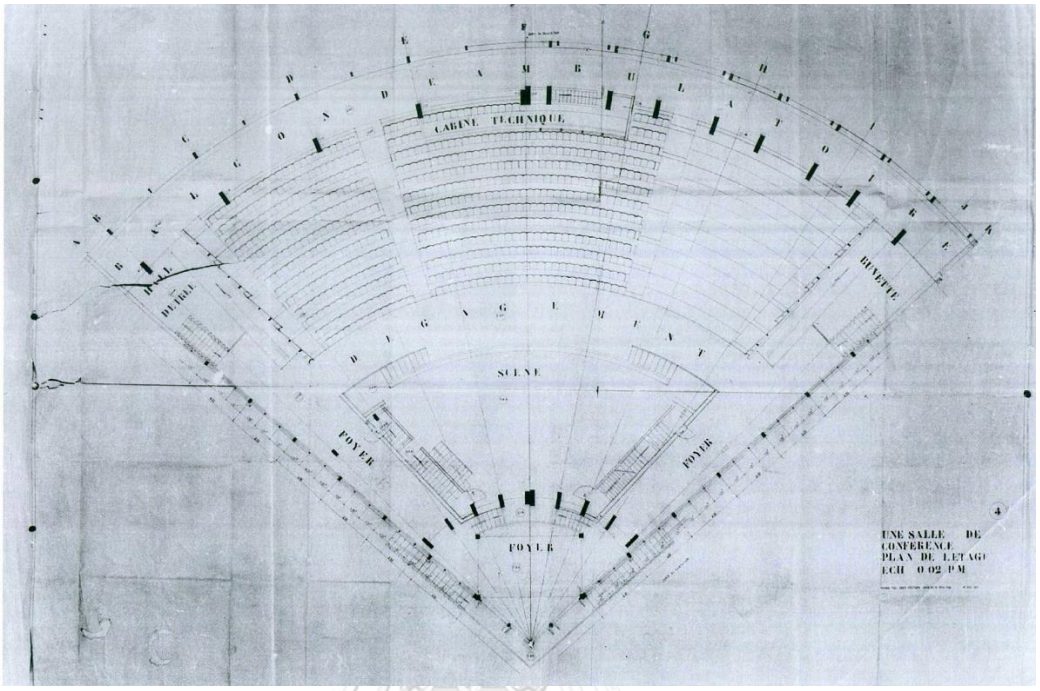


Elevation drawing (source: Vann Molyvann Project)

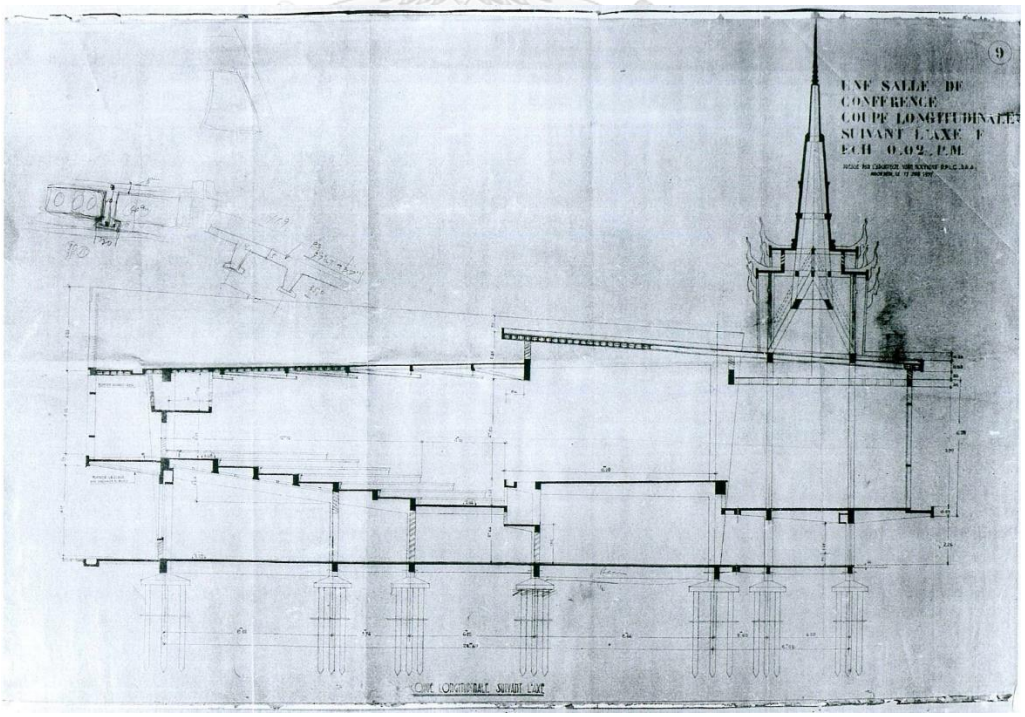
Section (source: Vann Molyvann Project)

Preah Suramarit National Theatre physical model (source: Vann Molyvann Project)

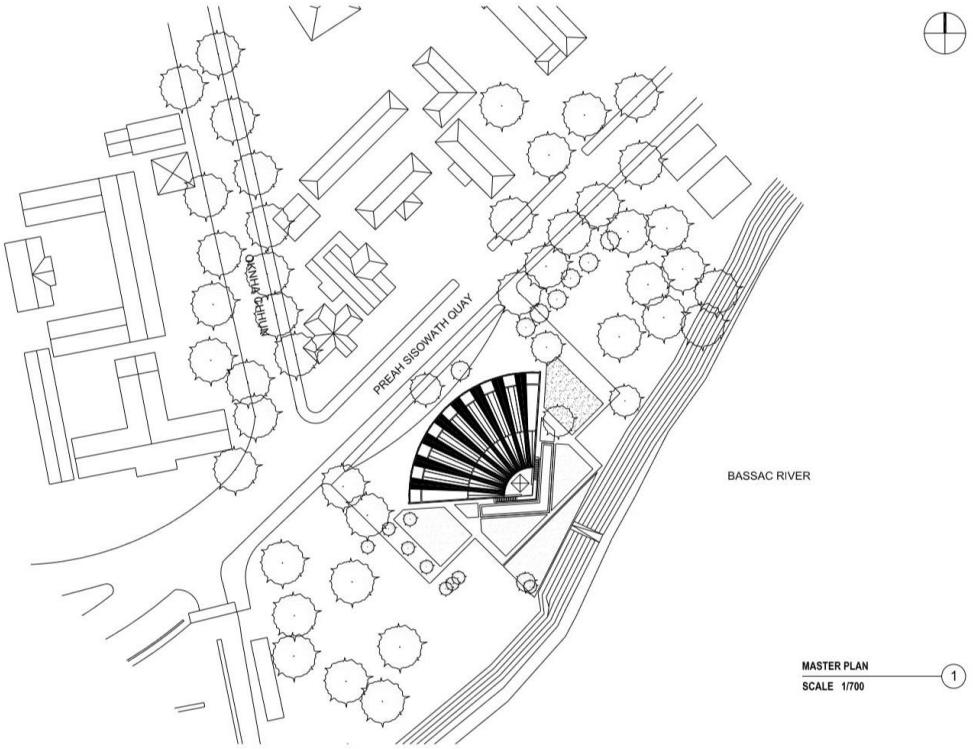
Appendix E: Chaktomuk Conference Hall



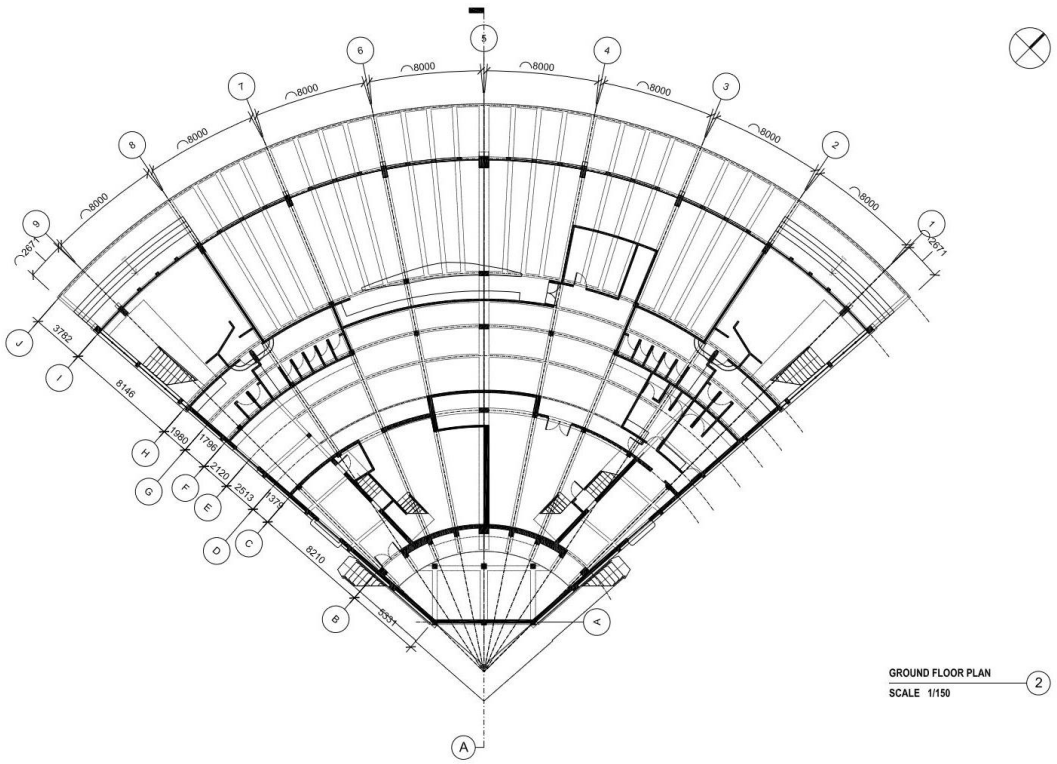
Floor plan (source: A+U Magazine)



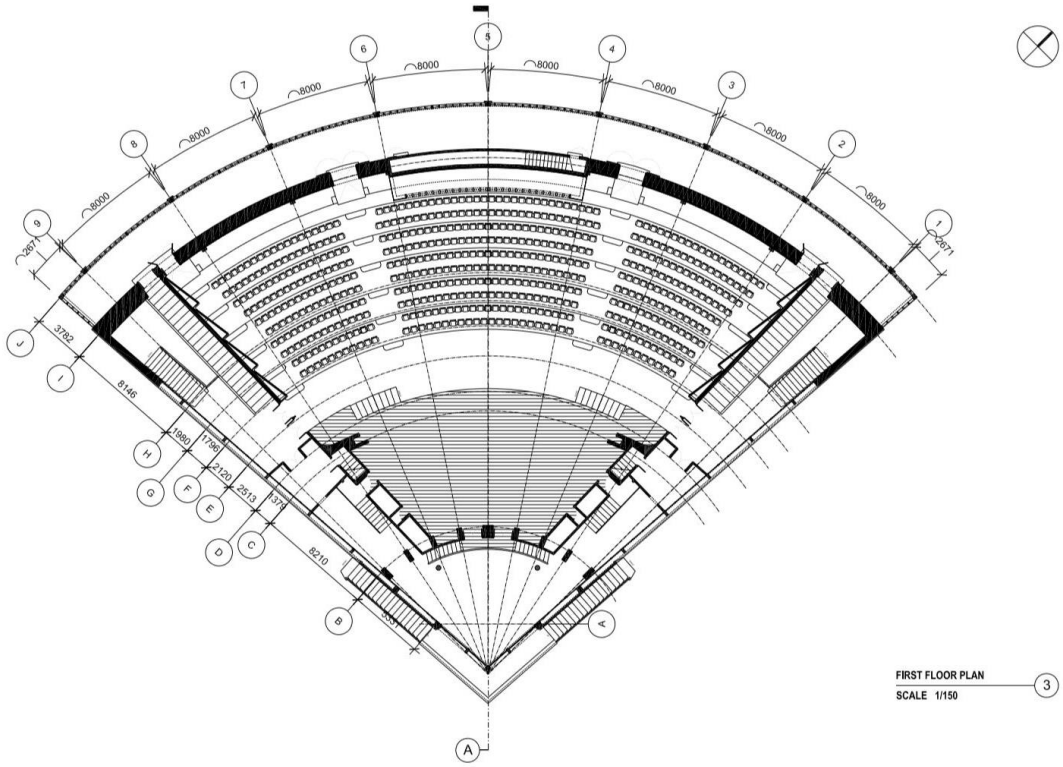
Section (source: A+U Magazine)



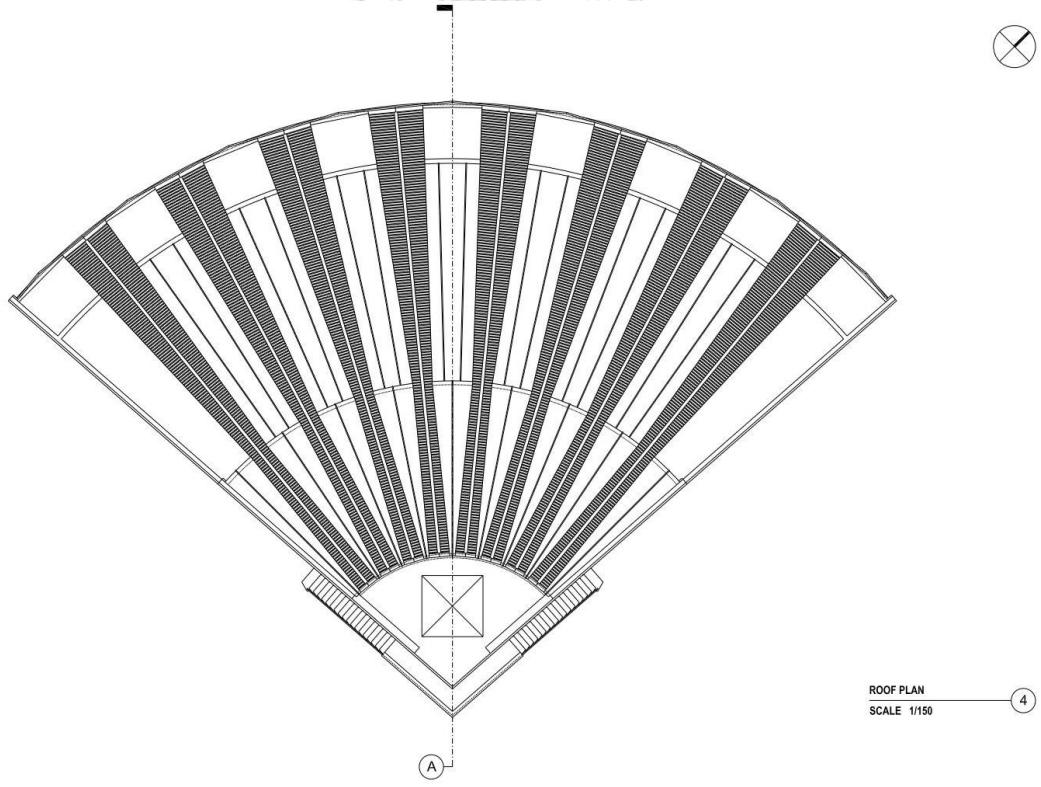
Master plan (source: A+U Magazine)



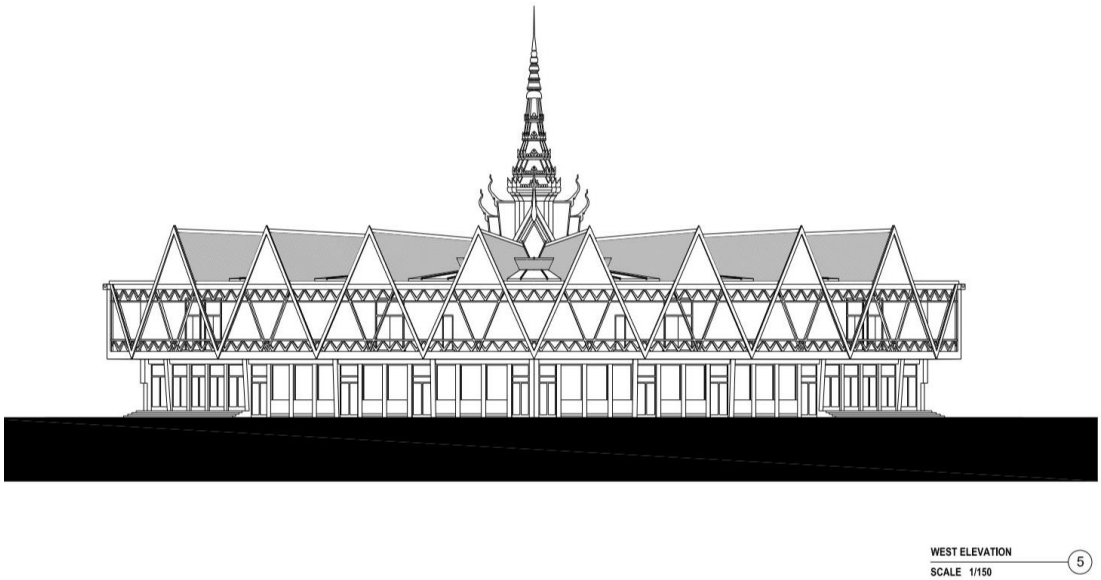
Ground floor plan (source: Vann Molyvann Project)



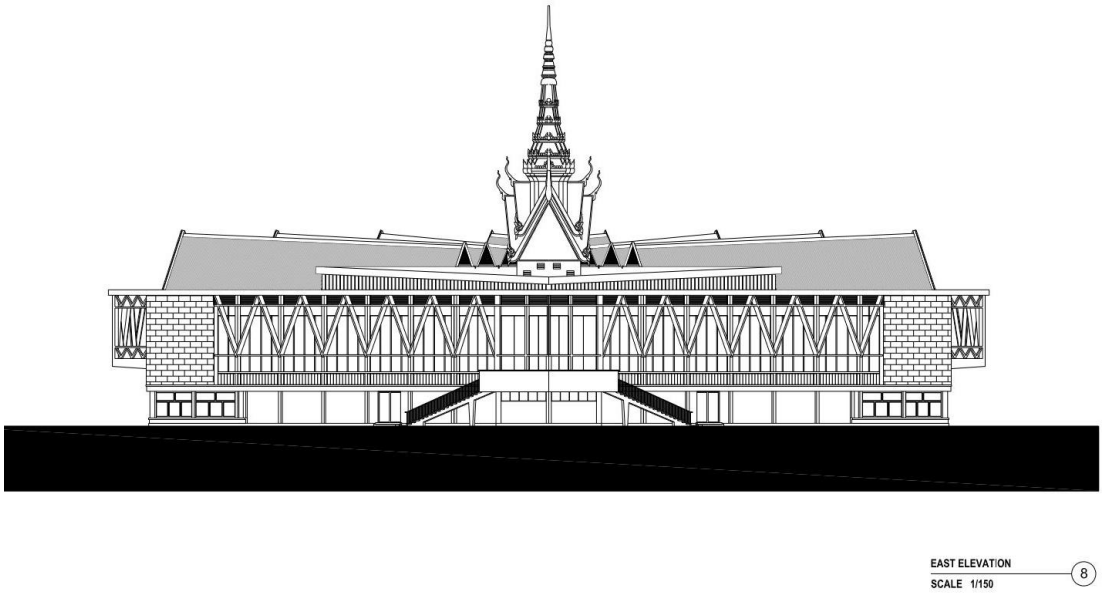
First floor plan (source: Vann Molyvann Project)



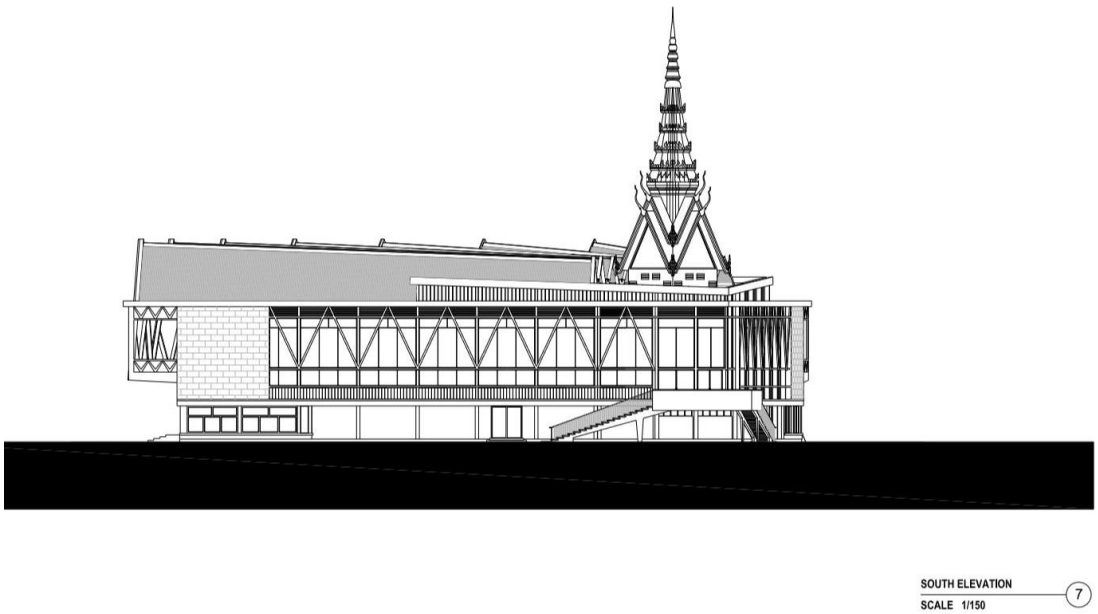
Roof plan (source: Vann Molyvann Project)



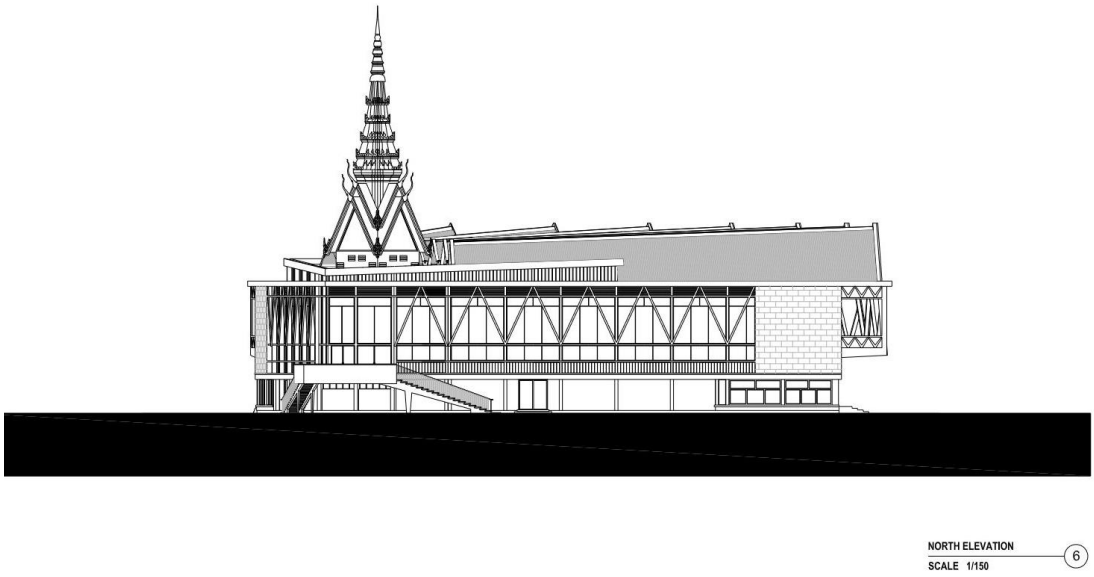
West elevation (source: Vann Molyvann Project)



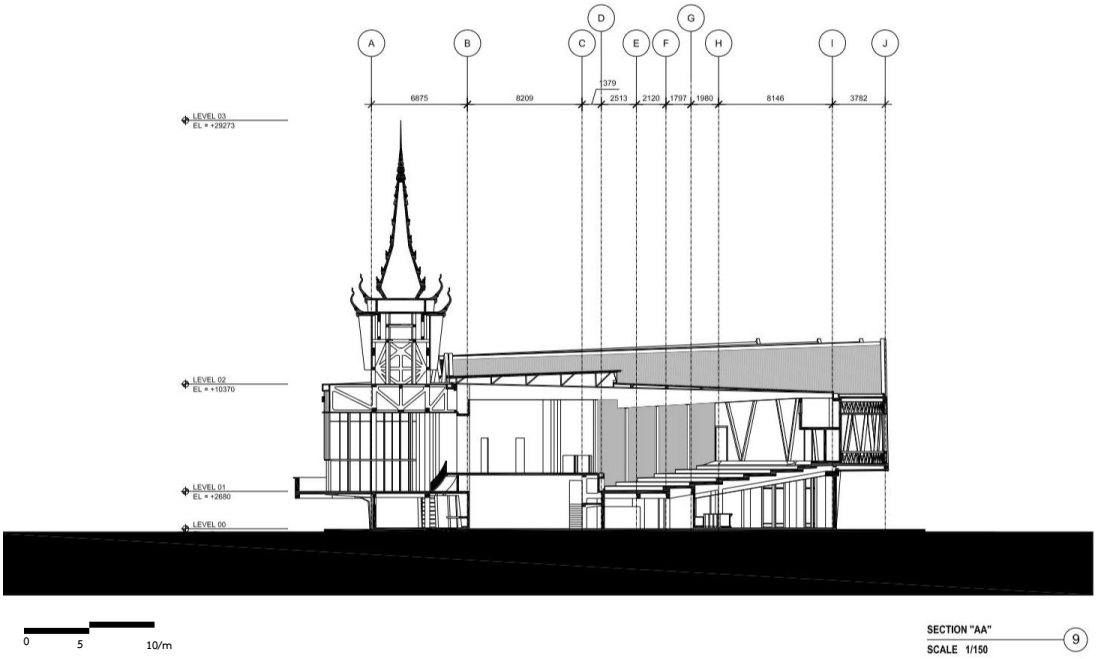
East elevation (source: Vann Molyvann Project)



South elevation (source: Vann Molyvann Project)

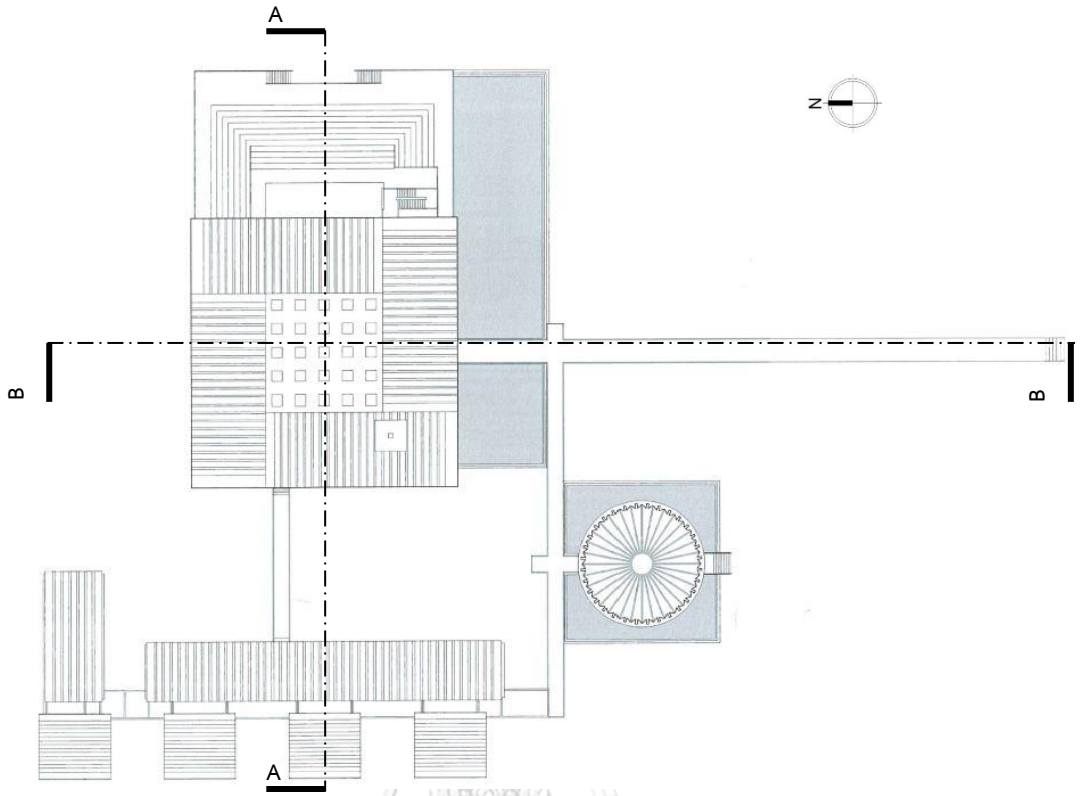


North elevation (source: Vann Molyvann Project)

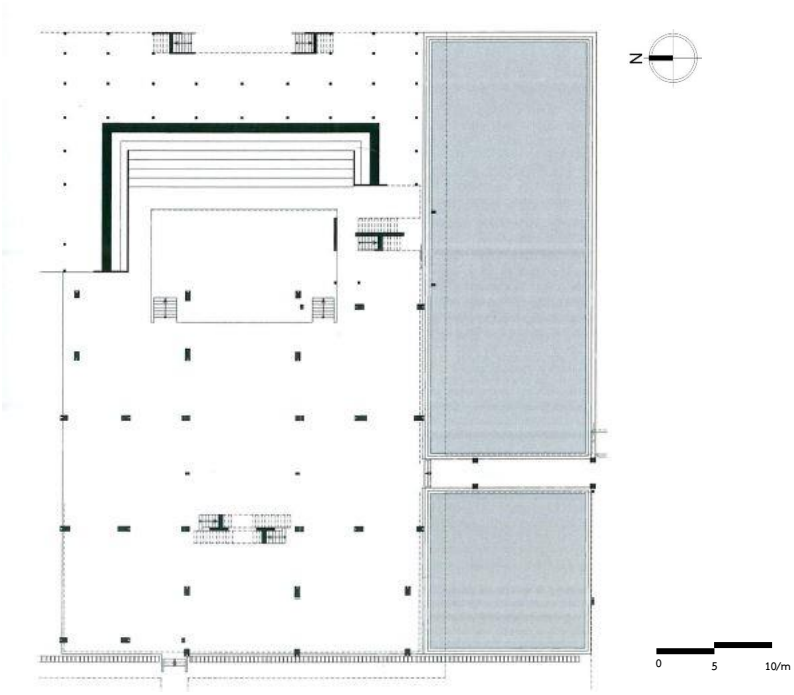


Section (source: Vann Molyvann Project)

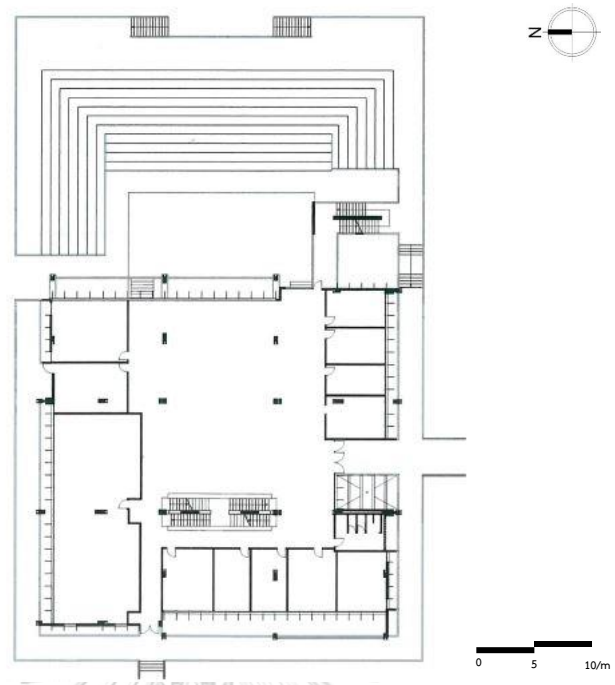
Appendix F: Teacher Training College



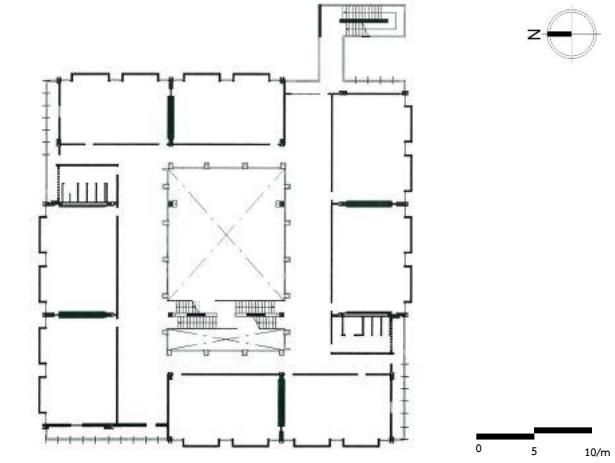
Site plan (source: A+U Magazine)



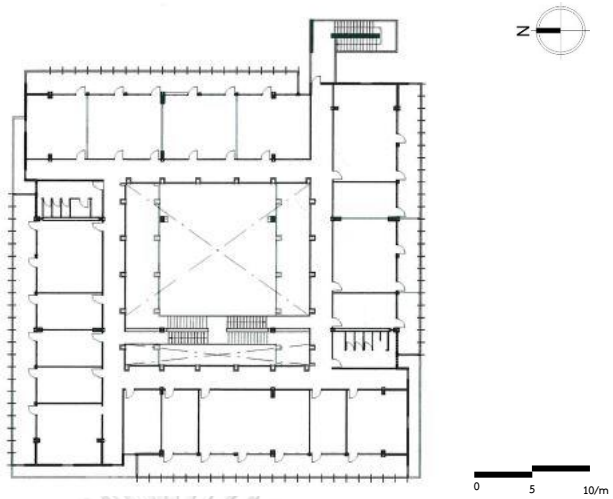
Ground floor (source: A+U Magazine)



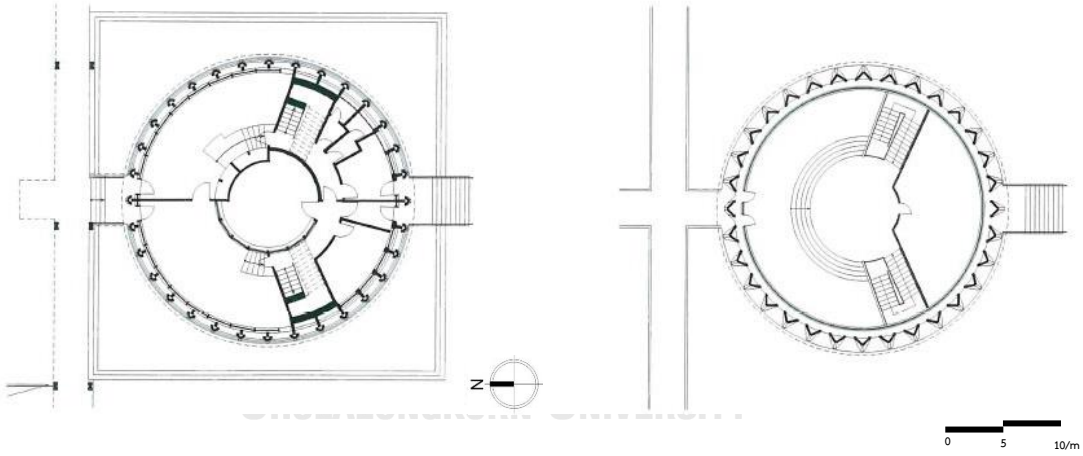
First floor (source: A+U Magazine)



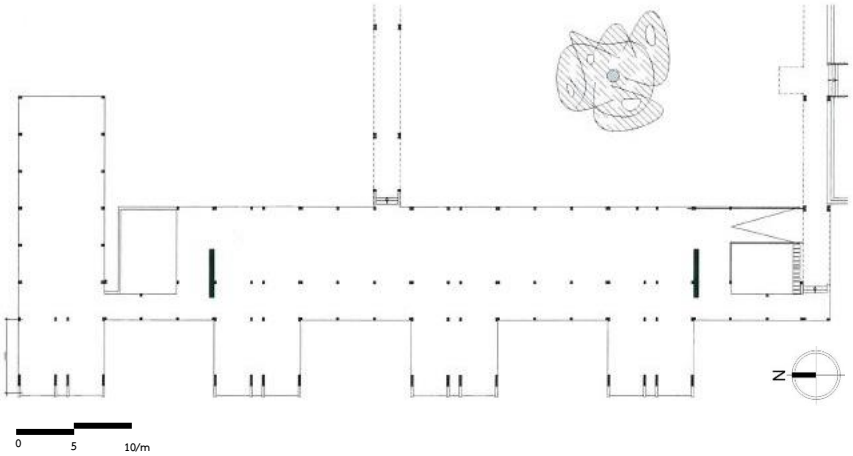
Second floor (source: A+U Magazine)



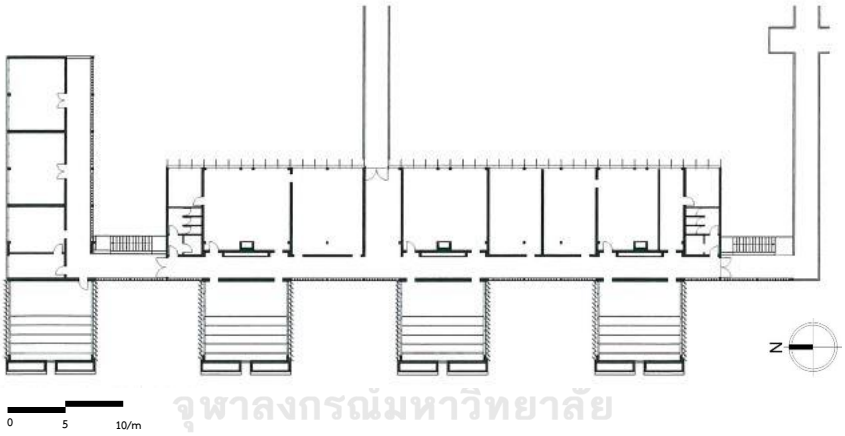
Third floor (source: A+U Magazine)



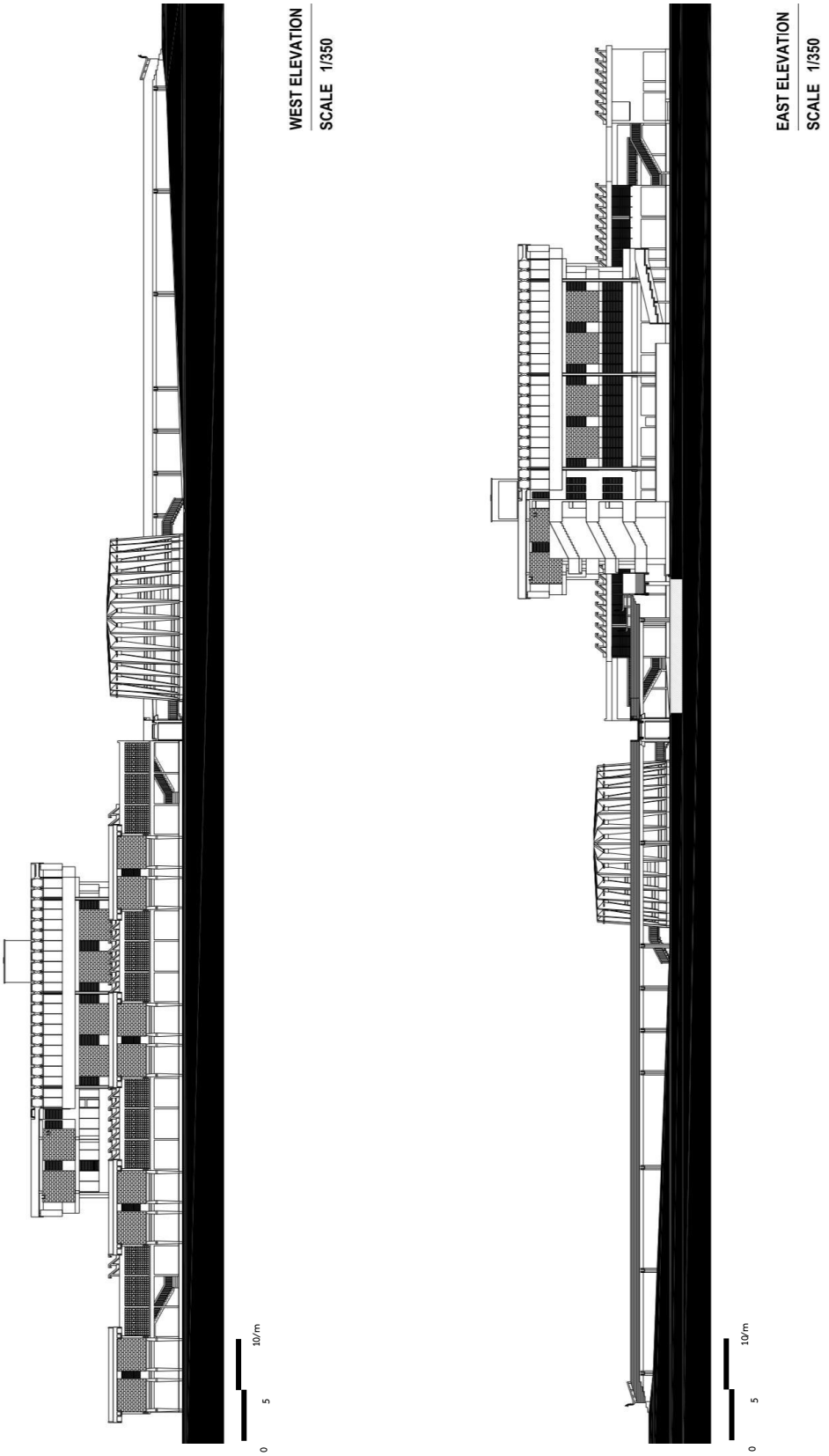
Library ground and first floor (source: A+U Magazine)



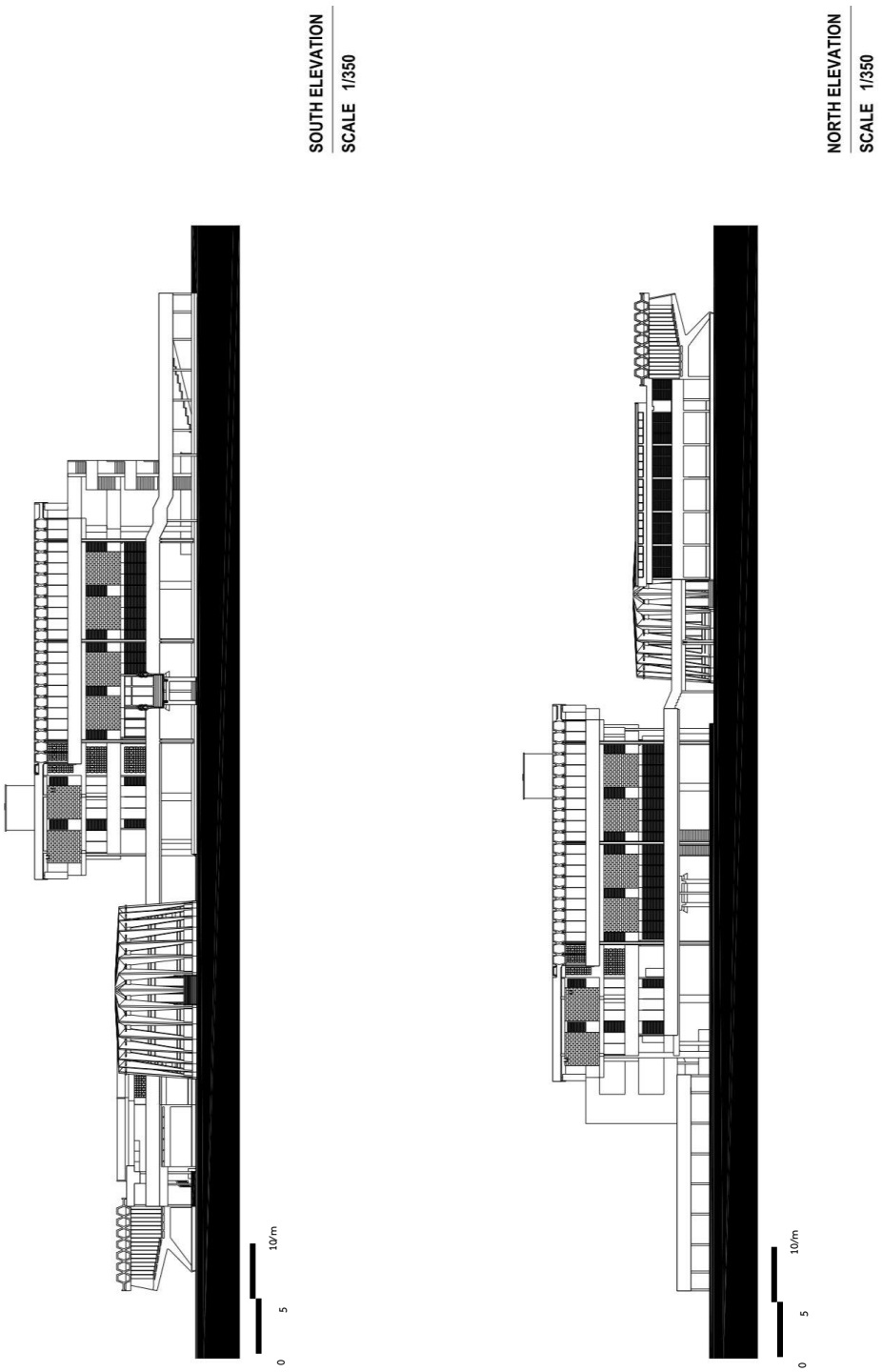
Ground floor (source: A+U Magazine)



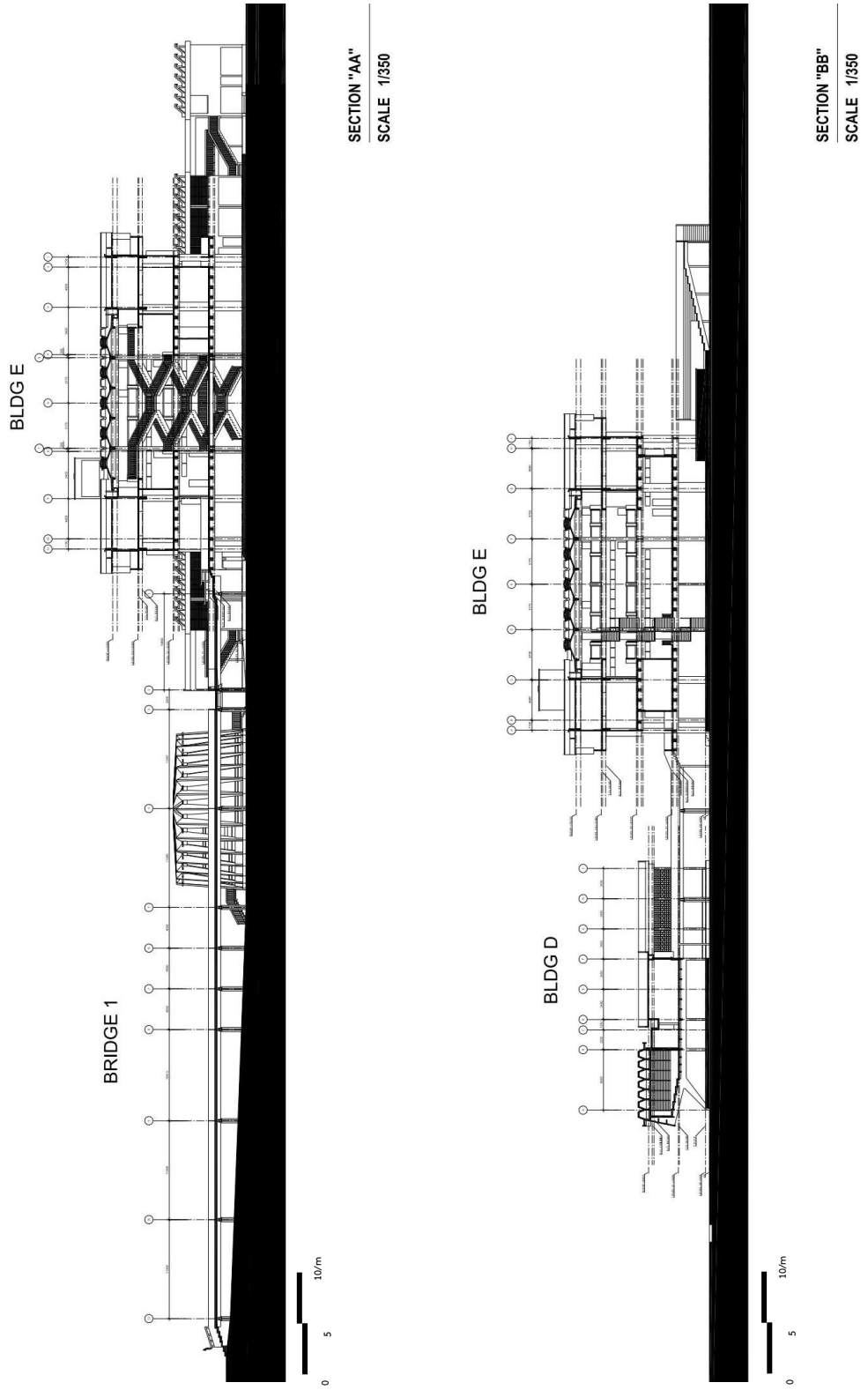
Classroom First floor (source: A+U Magazine)



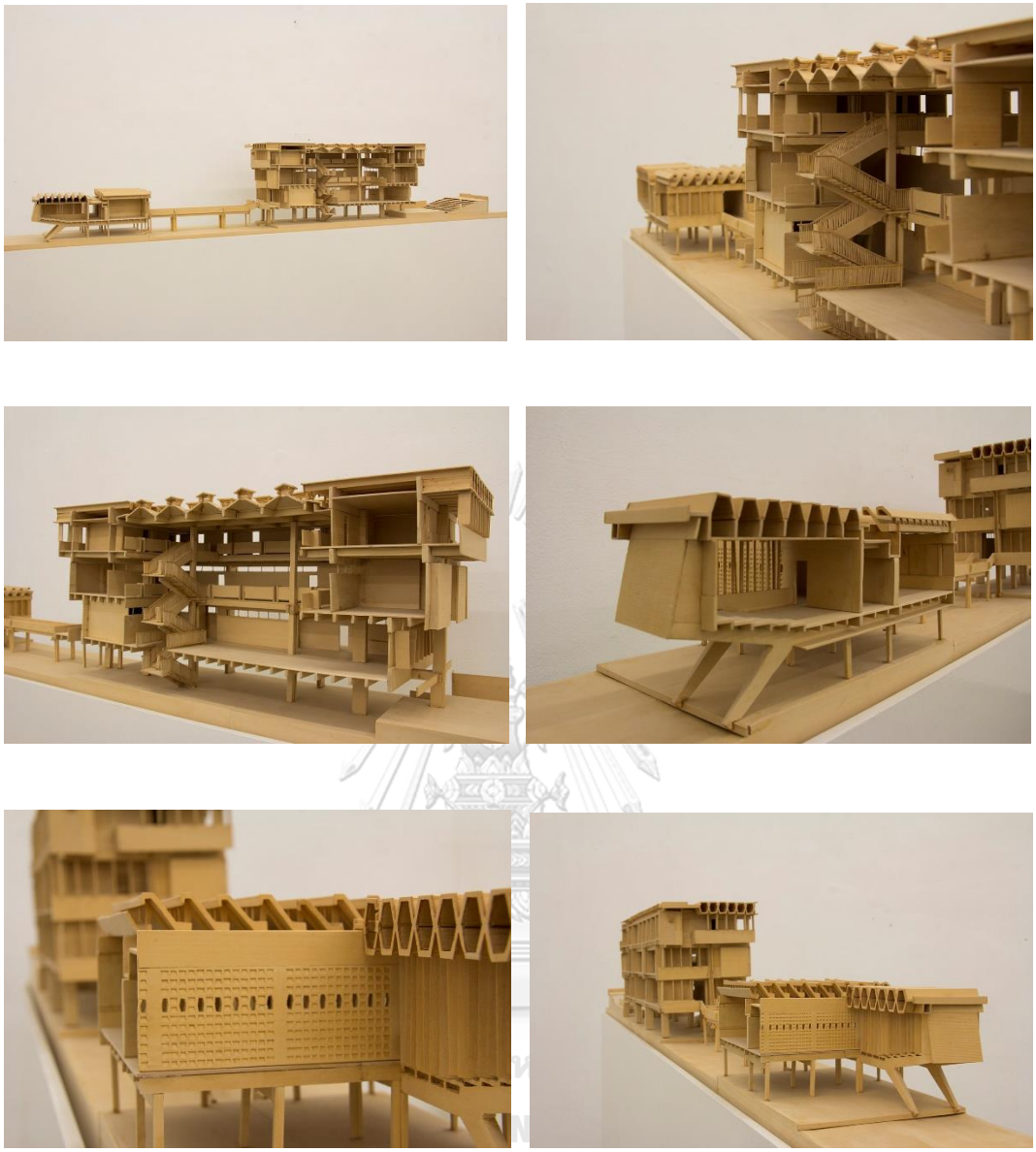
West (left) and east elevation (right) (source: Vann Molyvann Project)



South (left) and north elevation (right) (source: Vann Molyvann Project)

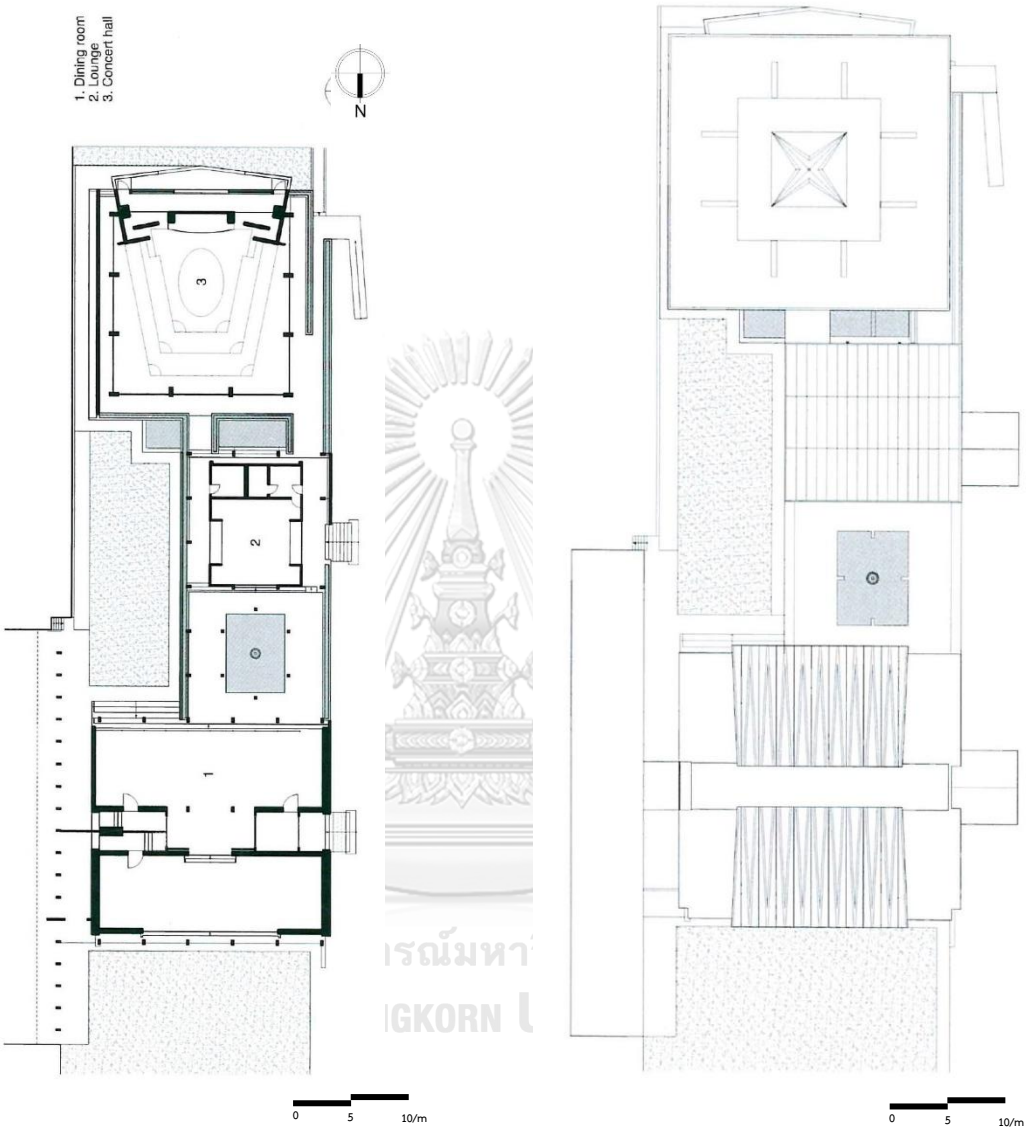


Section ‘A-A’, ‘B-B’ (source: Vann Molyvann Project)

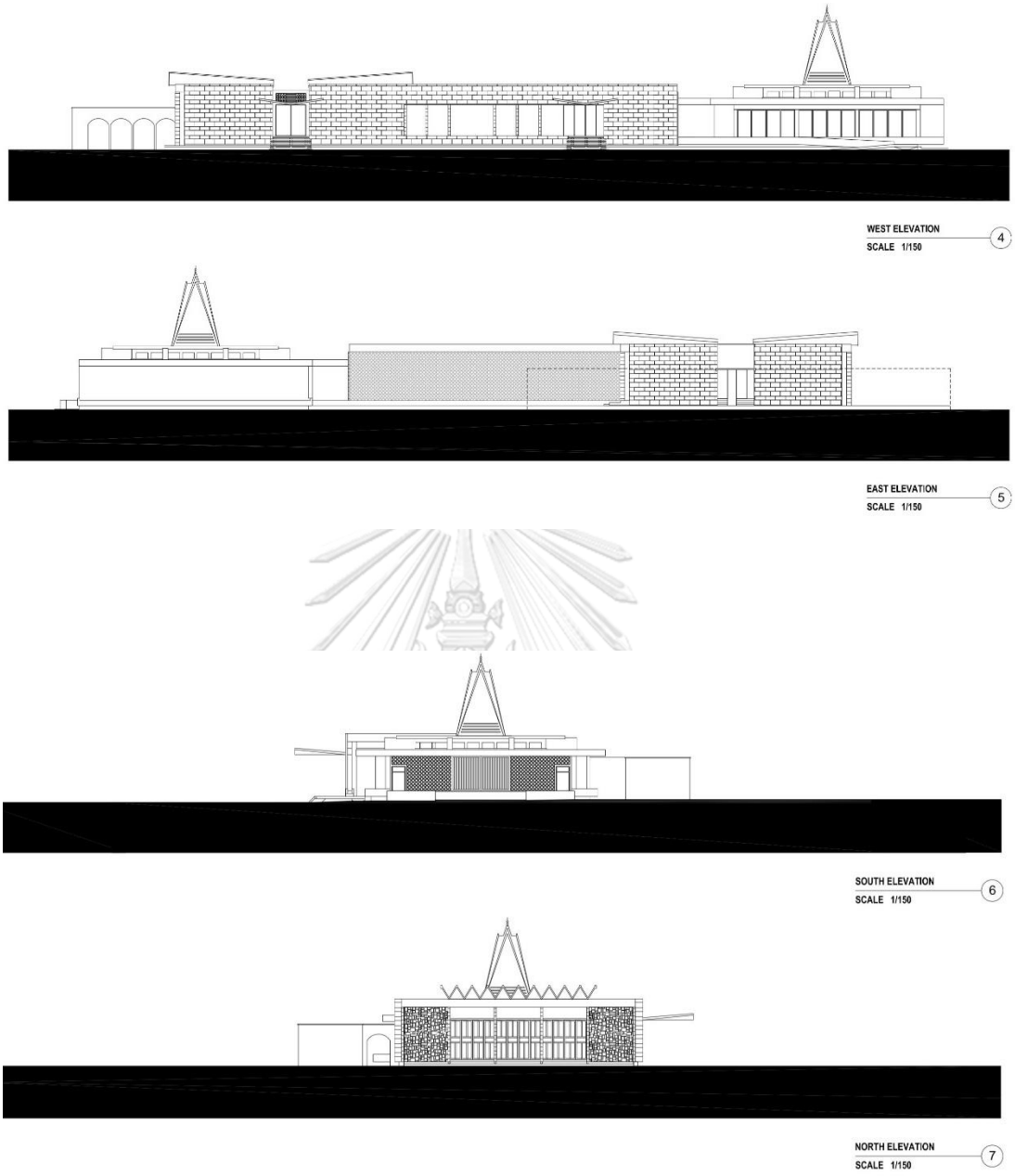


Teacher Training College physical model (source: Vann Molyvann Project)

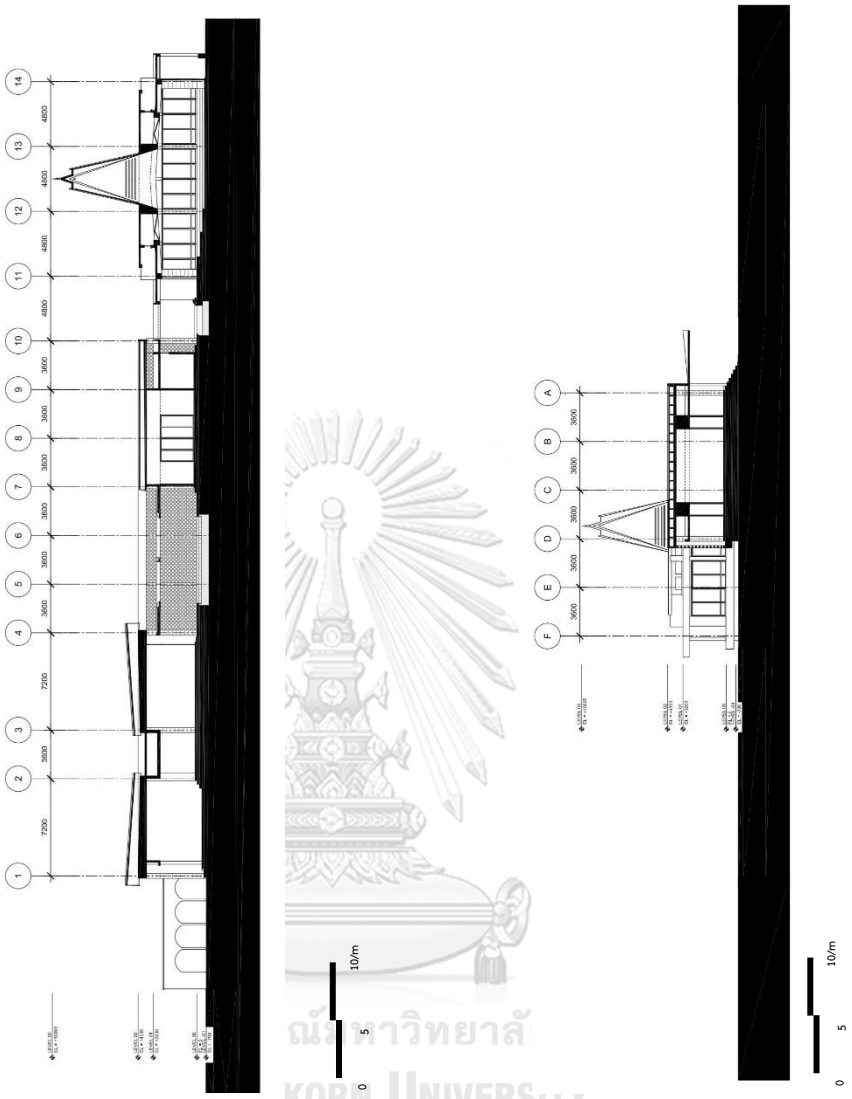
Appendix G: The State Reception Hall



Ground and first floor (source: A+U Magazine)

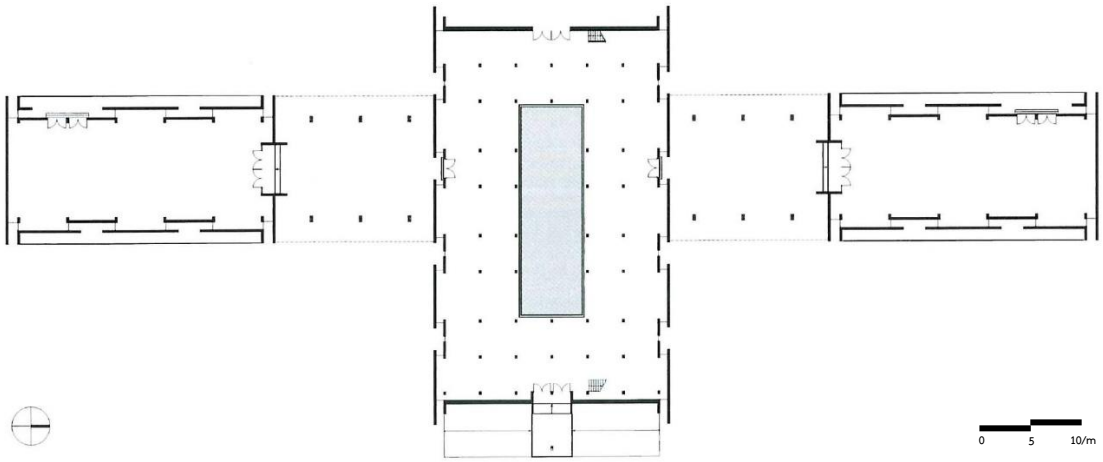


Elevation drawing (source: A+U Magazine)

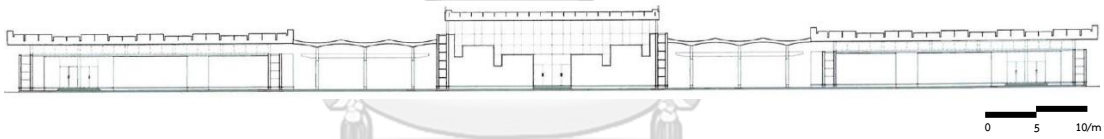


Section floor (source: Vann Molyvann Project)

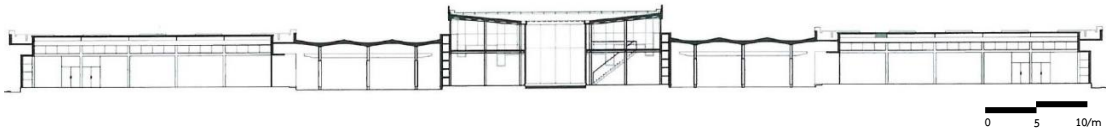
Appendix H: Sangkum Reastr Niyum Exhibition Hall



Floor Plan (source: A+U Magazine)

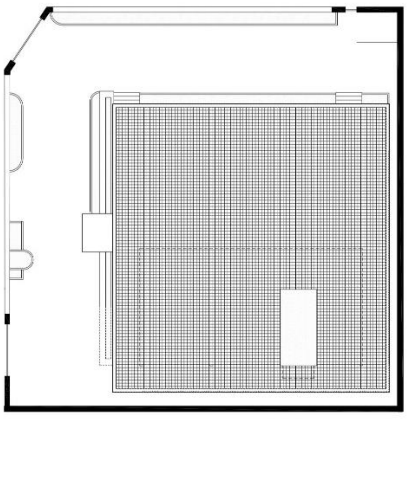


Elevation (source: A+U Magazine)

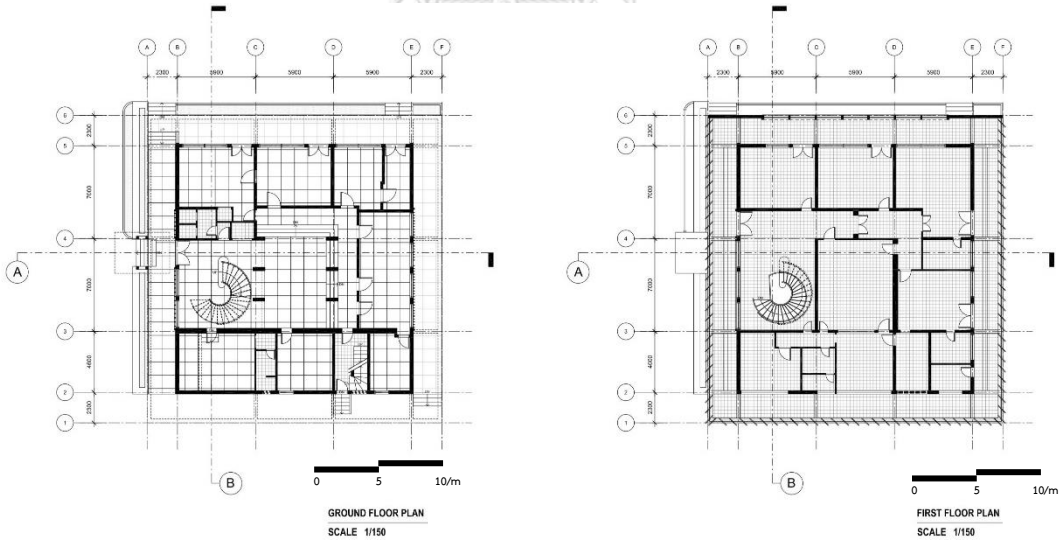


Longitudinal section (source: A+U Magazine)

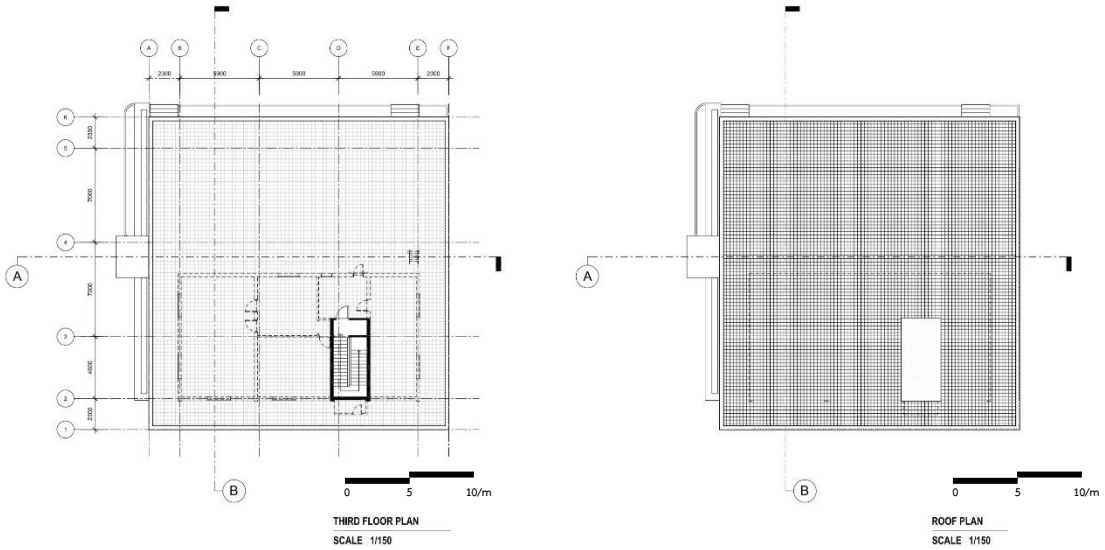
Appendix I: The House for Norodom Sirivuth's Mother



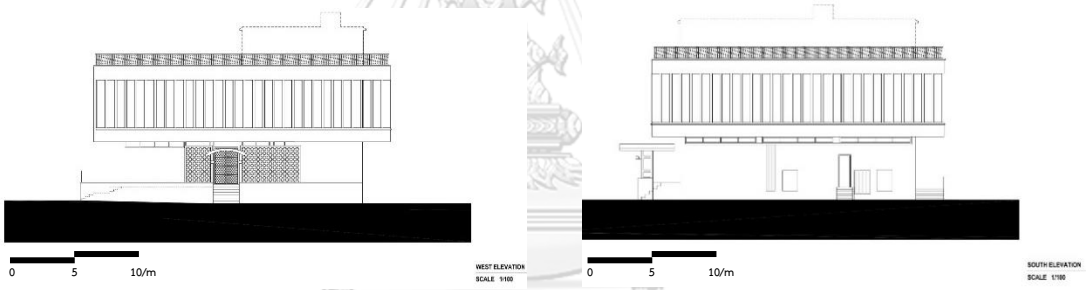
Master plan (source: Vann Molyvann Project)



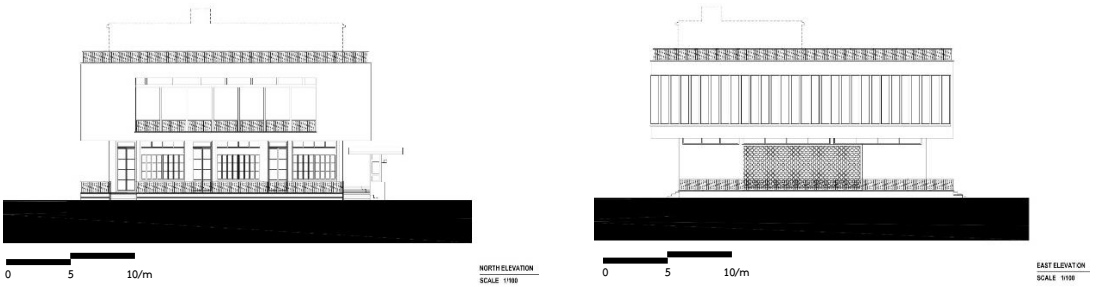
Ground and first floor plan (source: Vann Molyvann Project)



Third and roof floor plan (source: Vann Molyvann Project)



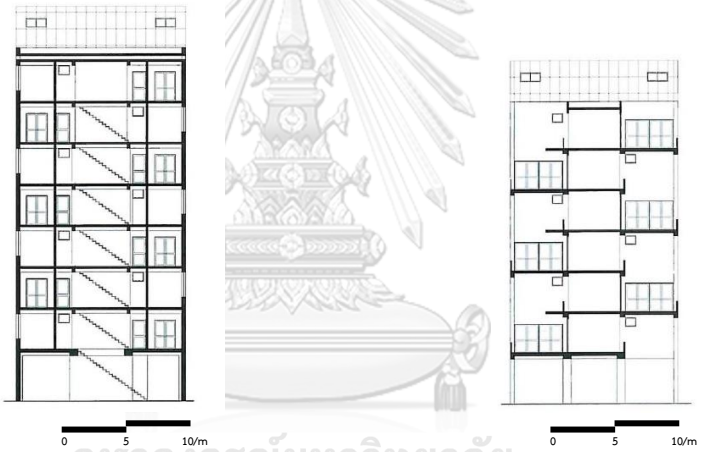
West and south elevation (source: Vann Molyvann Project)



North and south elevation (source: Vann Molyvann Project)

Section ‘A-A’, ‘BB’ (source: Vann Molyvann Project)

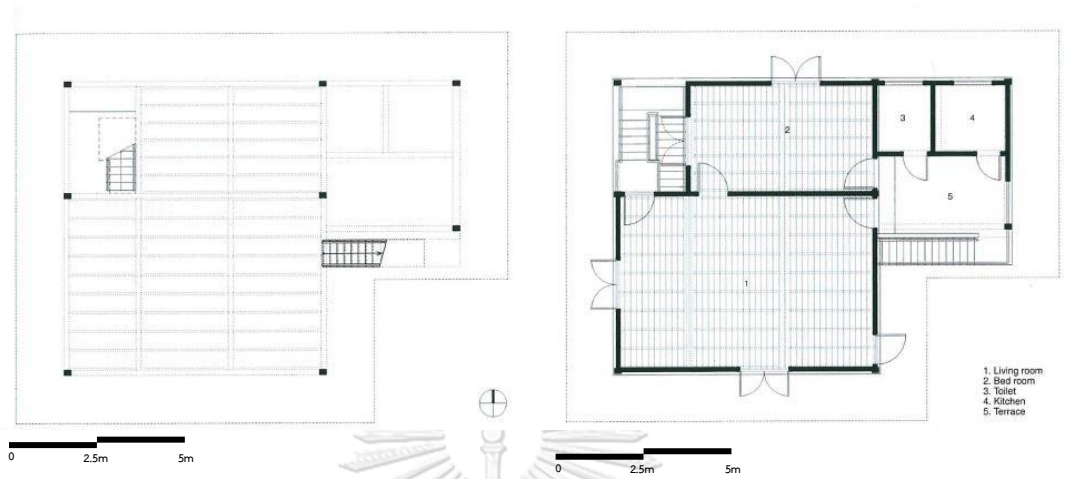
Appendix J: Olympic Village Apartment



Section of staircase and void (source: A+U Magazine)

Unit plan first floor (left) and second floor (right) (source: Vann Molyvann Project)

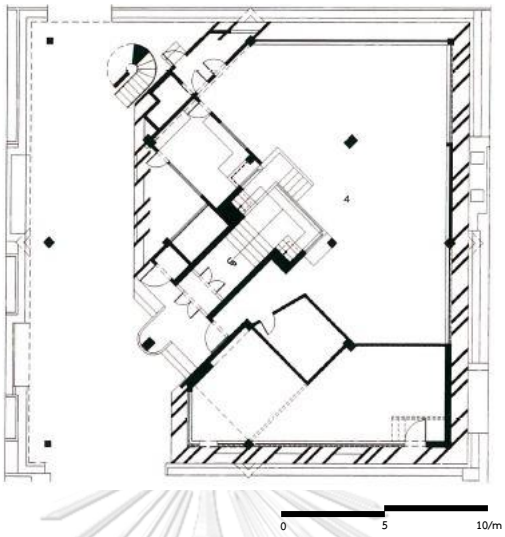
Appendix K: One Hundred Houses Project



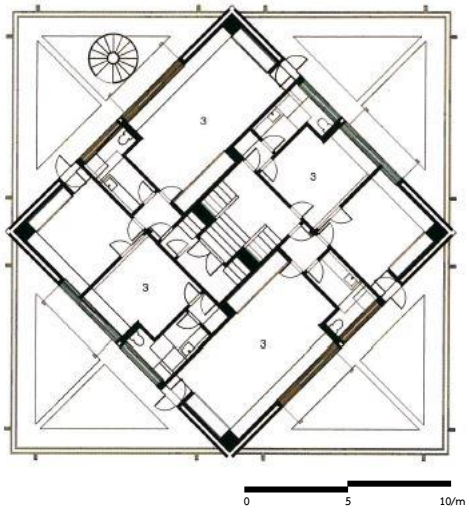
Ground floor plan (left) and first floor (right) (source: Vann Molyvann Project)

Section (left) and elevation (right) (source: Vann Molyvann Project)

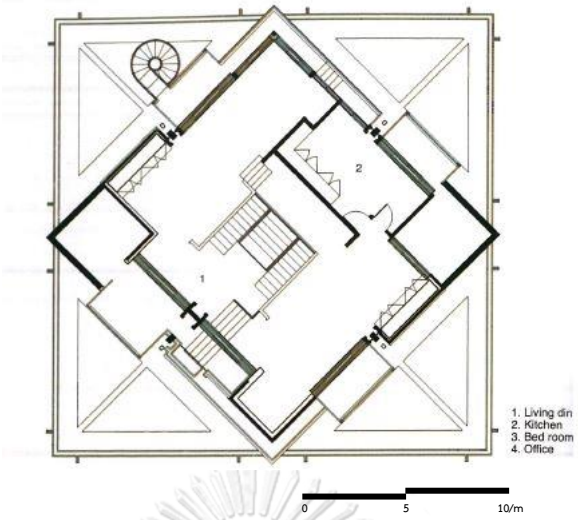
Appendix L: Vann Molyvann House



Ground floor plan (source: A+U Magazine)



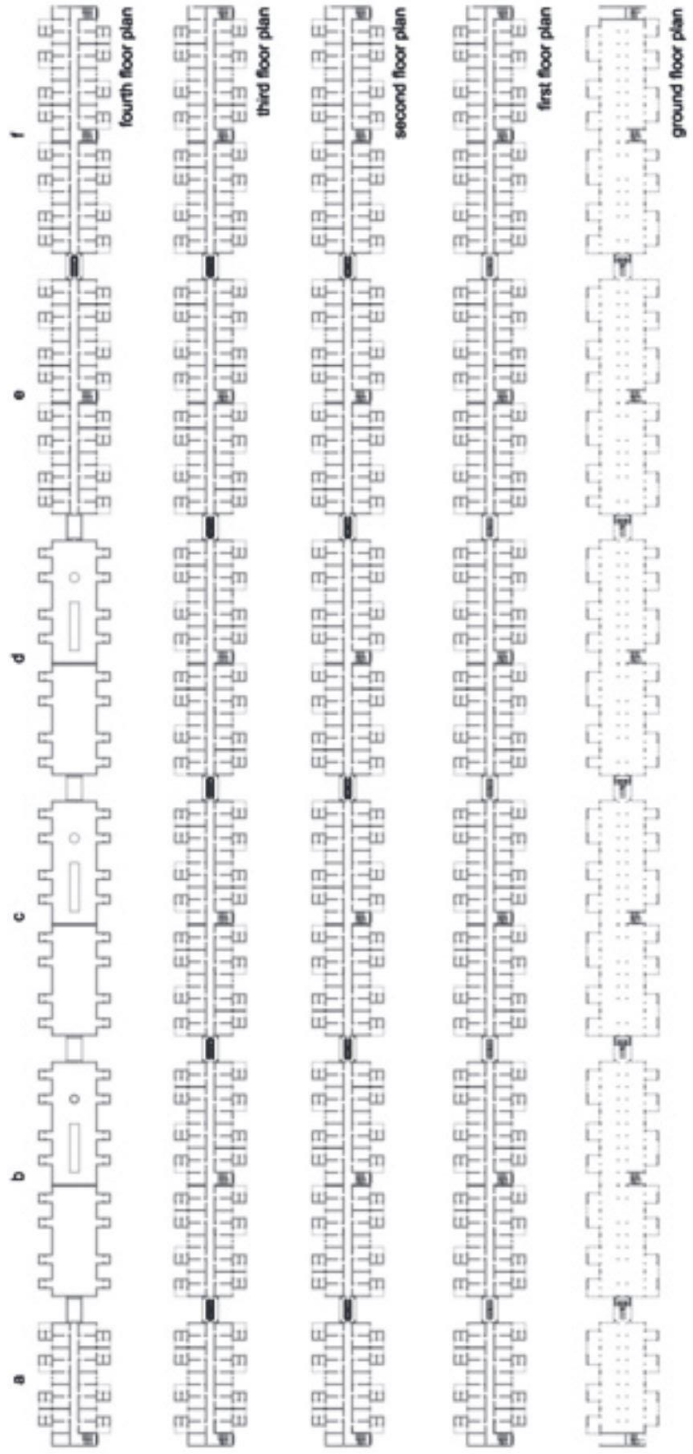
First floor plan (source: A+U Magazine)



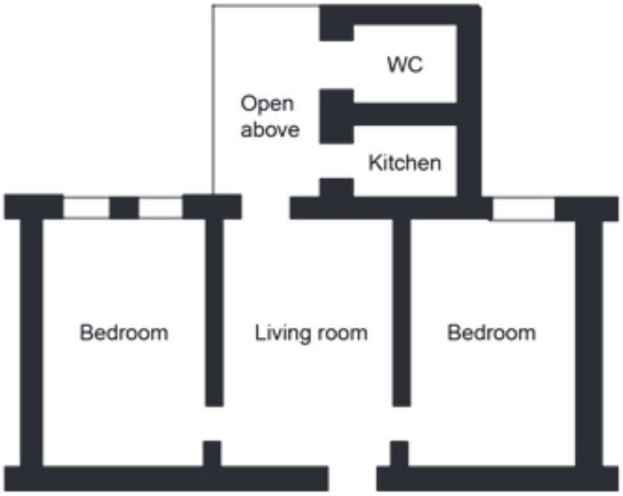
Second floor plan (source: A+U Magazine)

Interior View of the living room (source: A+U Magazine)

Appendix M: White Building Apartment



White Building Apartment floor plan (source: Nakara Journal)



Typical unit in White Building Apartment (source: Nakara Journal)

VITA

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His research paper entitled 'Tropical Strategy of Modern Architecture in Cambodia through the works of Vann Molyvann' was published on Sarasatr e-journal Vol.1/2018 of the faculty of architecture Chulalongkorn University, published on 11 April 2018.