Tropical Strategy of Modern Architecture in Cambodia through the works of Vann Molyvann

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Abstract

Cambodia has been developing in an accelerating speed in the past few decades. However, architectures were built without much concern of sustainability. Most of the newly built structures are simply equipped with air-conditioning system which costs high energy consumption. The purpose of the study is to search for architectural strategy dealing with the tropical climate for contemporary architecture in Cambodia with more appropriate technology and sustainability's approach. Large scale modern buildings in the pre- air-conditioned period specifically those built in the 1960s by Vann Molyvann, who is considered as a father of modern architecture of Cambodia are selected as case studies. The three buildings are The National Sport Complex, Preah Suramarit National Theatre and Chaktomuk Conference Hall which share the similar features of a big indoor space without minimal air-conditioned space. Architectural elements such as the walls, roofs, openings and other features that efficiently deal with tropical climate will be analysed in details in relation to the site and programs of each building. The research will use literature reviews, drawings and on-site observations to analyse the buildings of Vann Molyvann. The study would lead to an introduction of suitable tropical strategy for contemporary architecture in Cambodia and provide practical guidelines for future economical and efficient designs that can be implemented at a low cost in Cambodia and other regions of the world with tropical climates.

***Keywords**: Tropical Strategy, Air-Conditioning, Tropical Sustainability, Modern Khmer Architecture, Tropical architecture, Southeast Asian Architecture, Modern architecture in Southeast Asia, Vann Molyvann*

Problem of Contemporary Architecture in Cambodia

Phnom Penh is a fast-growing city in Cambodia in economic, infrastructure, population and architecture. New contemporary building such as commercial buildings, residential buildings, and office buildings are rapidly growing (Fig. 1). In spite this rapidly growing, the issue that affects them most is the architectural design. Many built buildings are failing to be sustainable due to many climatic factors in the country. Due to the incapability of architects to making buildings that are strong for the climatic conditions, the people of Cambodia are forced to use air conditioners to at least cope with the conditions. These air conditioners installation is expensive, and also it uses a high amount of energy. Many people cannot afford this and also the use of energy is not economical country-wise hence it is not maintainable. These architectural issues are alarming since many buildings which are important to the citizen of Cambodia.

Figure 1 Phnom Penh city in 2016 (source: http://business.inquirer.net/204448/from-ghost-city-to-boomtown-phnom-penh-soars-high)

Modern Architecture in pre-air-conditioning period could help to render the strategy dealing with tropical climatic condition. Architects of that time have to be extra careful when dealing with the weather, for example, temperature variations, cold and hot storms and several other effects of environment. Vann Molyvann who is the father of modern architecture in Cambodia is one of the greatest examples for the country. His strategy to deal with the climate problems in the country with a sensible solution with also limited technology as well as cultural contexts should be discussed. People need to be safe in their homes that can resist the disturbing tropical conditions could boost their courage. Vann Molyvann has showed his countrymen that it is possible to deal with the tropical conditions issues through his works.

Modern Architecture in Cambodia

Modern Khmer Architecture successfully combined the Cambodian culture, modern design, and tropical designs in coming up with designs that can withstand the prevailing climatic and environmental conditions. Vann Molyvann is an example of the Cambodian architects who pioneered the adoption of such techniques in design. Vann Molyvann has been credited as the founder of the modern architecture in Cambodia, based on the numerous architectural landscapes that he designed or oversaw in their development. Vann's famous public works that were built to sustain of tropical climatic, included The National Sport Complex, Teachers Training College, Chaktomuk Conference Hall, State Palace. Lastly, Vann designed the Olympic Village Apartment, The Preah Suramarit National Theatre, Sangkum Reastr Niyum Exhibition Hall, which is part of Bassac Riverfront Project, determined public urban development flagship project founded on reclaimed land of Tonle Sap River (Ross and Collin 2006).

Tropical Climate and Architecture

Cambodia is a tropical climatic region, with consistently high temperature range of 21 to 35 ^{o}c, and two seasons are recognized: monsoon-driven rainy season (May-October) moist air between 80-90% is drawn landward from the ocean bringing the southwest monsoon rains to Cambodia. Coming to a dry season (November-April), the air pressure rises, driving cool dry air back and bringing on a largely rainless to the region (THE WORLD BANK GROUP 2011). Hence it faces various climatic challenges. In the case, buildings are built in a manner that reduces or avoids these problems. The New Khmer architectural designs incorporated styles that were tropical suites. Examples of these architectural designs included; orientation of the buildings facing north to allow cooling from the vast forest.

Sustainable Development

Currently, electric air conditioner is used to control indoor climate. Cambodia did not use this form of technology during the New Khmer dispensation in the 1960s but instead the architects of the time began to alter in significant ways by invented and applied modern construction techniques in their architectural designs to earn the indoor comfort. Energy conservation debates are on the rise on most urban cities. Some of other strategies "greener" such as planting vegetation around buildings to reduce excessive heat and humidity are also being introduced to encourage sustainable development (Lewis 2016). Sustainable development is not only taking place in Cambodia but also in all states experiencing adverse climatic changes.

The Three Buildings (The National Sport Complex, Preah Suramarit National Theatre, Chaktomuk Conference Hall)

Air conditioners are crucial elements in contemporary buildings in the tropical regions due to the rapid climatic changes that result in temperatures of up to 30 ^{o}C. The air conditioning system usually leads to high energy consumption as well as high construction expenses. The rationale for choosing the

three building of Vann Molyvann as case studies is their low size to air conditioning ratios. The three buildings are spacious and are either partly or totally not equipped with air conditioners. Not having air conditioners in buildings with small volumes is relatively easier than those with large spaces. The large buildings would require a more complex strategy to deal with tropical climate with the least air conditioning system.

Then National Sport Complex's indoor arena, for instance, has wide spaces that usually require an air conditioning system. It is venue whereby numerous sporting activities take place. As such, athletes, spectators and other sports persons in indoor arenas of sports complexes perspire and might require systematic airflow to cool their bodies after sporting activities. An air conditioning system can potentially regulate air flow within the buildings. The indoor arena of the complex comprises of 8000 seats; a large capacity that requires adequate ventilation. Therefore, the absence of an air conditioning system in the National Sports Complex makes it a building of interest for this study.

The conference and auditorium also have a large space that require adequate air circulation that can be provided by an air conditioning system. However, the two buildings were designed to utilize natural ventilation along with a minimum usage of air conditioning systems. Despite the various health benefits and aesthetic values of natural air conditioning, the large numbers of individuals visiting the two buildings, especially the auditorium cannot be sustained by only natural ventilation. Therefore, the auditorium and conference are crucial to this study due to their air conditioning requirements.

The National Sport Complex

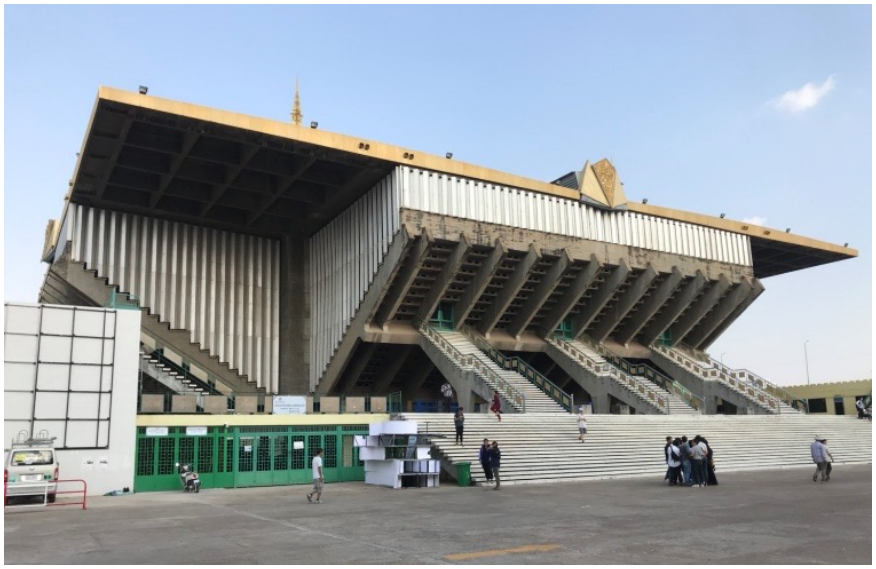

Figure 2 The National Sport Complex main building. Photo by Ty Pisith, March 8, 2018.

The most significant example of locally inflect innovation is the design of The National Sport Complex located in heart of Phnom Penh (Fig. 2). Consist of three main elements outdoor stadium 50,000 seats, while indoor arena, swimming and diving arena contained 8,000 seats in total. Building constructed

in 1962 anticipating for hosting Southeast Asian Game in 1963, also, to indicate the development and strength of Cambodia after gained independence (Ross and Collin 2006). Sensitive to climatic conditions, the building prudently modulates air, water, and light. It is a good design of architecture showing off the ideas of green or bioclimatic design. It's give precise techniques used in drainage and water management, National Sport Complex has a good drainage system with the facility. It houses shallow storage ponds connected to the roof in which rainwater accumulates during storms to prevent flooding and then it drained out at a slower pace (Fig. 3). Main building or indoor arena. The three slanted surface structures of the house functioned as a wall and audience seats (Fig. 4). Beneath the seats, there are hole punches that provide soft light, cross ventilation for indoor arena and as shade for the outdoor walkway of the arena (Fig. 5). Intertwining aluminum panel's screen which also allowed the ventilation and indirect sunlight from the outer and inner gap of the panels otherwise all the corners of the arena would be wall-less (Fig. 6).

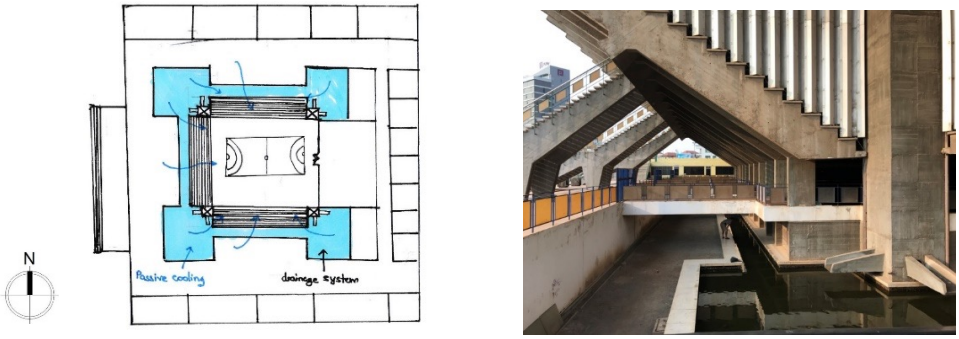

Figure 3 Water drainage system around indoor arena. Photo by Ty Pisith, March 8, 2018

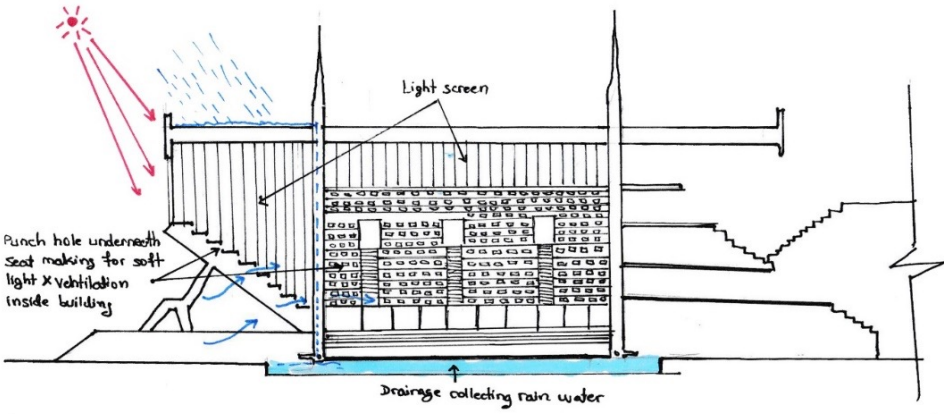

Figure 4 Diagram drawing of a slanted wall functioned as a wall and audience seats.

Figure 5 Hole punches underneath of the audience seats provide a soft lighting and ventilation into the indoor arena. Photo by Ty Pisith, March 8, 2018.

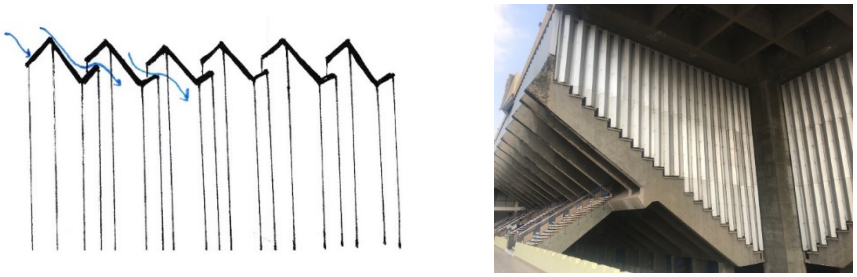

Figure 6 Intertwining aluminum panels allow the soft light and ventilation. Photo by Ty Pisith, March 8, 2018.

Even the roof of the arena, Vann still continue to keep his concept of indirect sunlight by using the exterior part of the roof as shade for outdoor audience. While the interior part of the arena sheltered underneath the three quarters of the four-single detached droopy square shaped rooftop for the purpose of seating arrangement (Fig. 7). The opening space in between the four main rooftop structures is covered by another opening gable roof that raises about half a meter above the primary structure that allows for indirect sunlight and air circulation from side louver into the building of so-called the breathing skylight (Fig. 8).

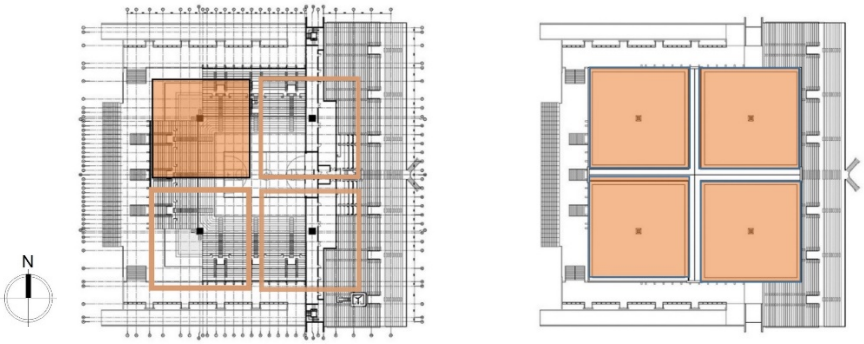

Figure 7 Roof layout showing a four-square roof covered indoor arena and outdoor audience's seat of the main building.

Figure 8 The opening space in between the four main rooftop structures is covered by an opening gable roof that allow indirect sunlight and air circulation inside indoor arena. Photo by Ty Pisith, March 8, 2018.

Every roof is supported by a single column at the center that remind the audience of an opening umbrella. The huge scuppers sat in vile of each column nourish a moot or perimeter drainage on the ground floor of the arena out ring walls to collect the rainwater from the cap of the building, which leads to cooling of the seating above and heat reduction inside the building. With looking on the opposite side of the out stadium, the topmost of the eastside there are three separated pendulous concrete roofs reverberate the roofs of the interior stadium crosswise the arena and offer shade for the Spinning Complex created on the ridge's eastern slope.

Preah Suramarit National Theatre

Figure 9 Preah Suramarit Theatre in 1966. (Source: https//www.vannmolyvannproject.org)

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 shape of resembles a ship as seen on the banks of the Bassac River (Fig. 9). The idea was to have a wide stage that was important for Cambodian musicals and drama with a suitable dimension to allow the spectators to see the stage (Rann 2012). Theatergoers need to enter beneath a triangular concrete fronton that set on a stilts raise above the ground level, where the staircases leading to a double-height foyer lightened and aired by complete height claustra. A pool in the basement of the step center and calm space. Pool helps

air to circulate so well at the theatre, in line with climatic condition (Fig. 10). Even though there are no windows, Vann come up with a new design of a pre-fabricated ventilated wall resembling fish scales (hexagonal shape) were made of particularly designed as a wall cladding, which provide filtered light and ventilation into the building (Fig. 11).

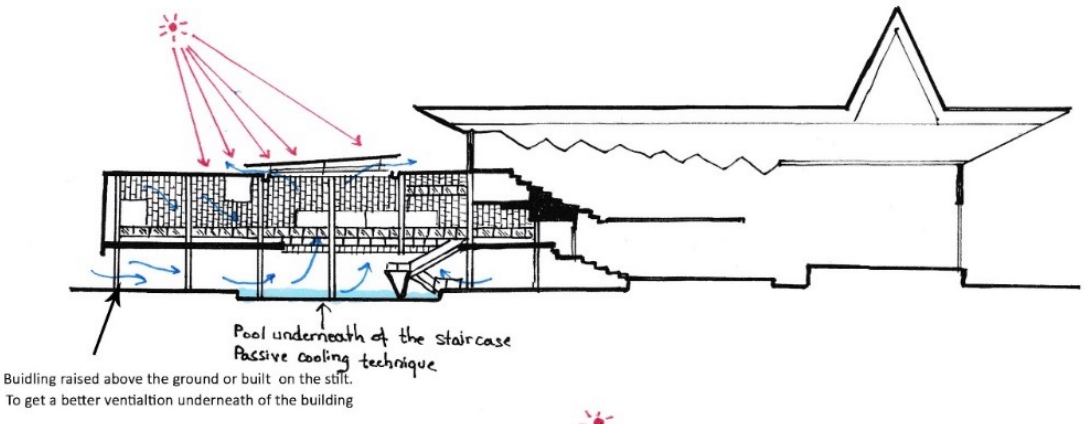

Figure 10 Diagram showing the center pool in the basement helping cool air to cool down the building.

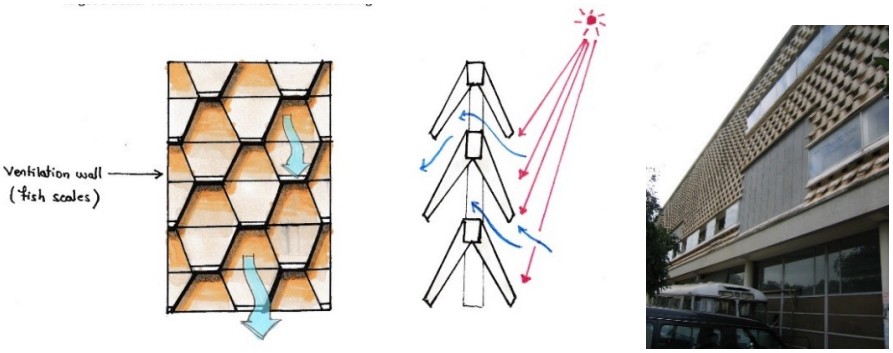

Figure 11 Diagram and Picture showing fish scales cladding wall.

Moreover, besides from the auditorium roof design that explodes in a pyramid shape, which somehow it succeeds look as khmer, another interested architecture element is a triangular roof on the fronton building that functioned as breathing skylight combined the ventilator with skylight, helping to solve the lighting and ventilation in one time by letting indirect sunlight to enter form the side and shutter to let the fresh air enter and foul outside of the building (Fig. 12).

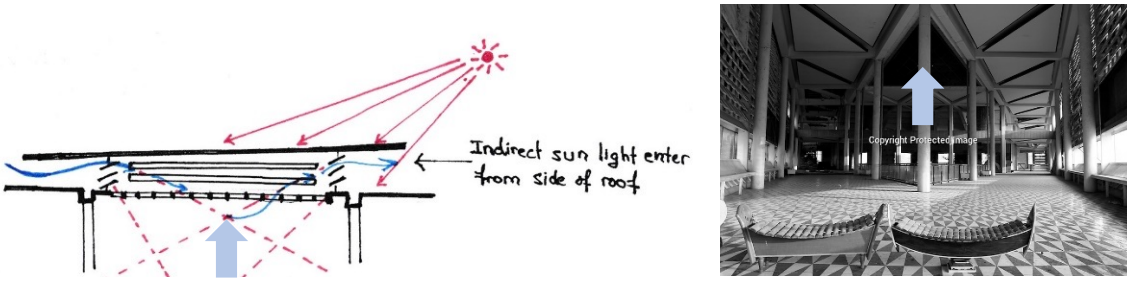

Figure 12 Diagram and photos showing the breathing skylight of the triangular roof on the fronton building. (Source: http://jeanloncle.photoshelter.com/gallery/The-Burnt-Theatre-Cambodia/G0000K1rA9rgrO7w/)

Through further study there was no actual evidence on how and where the air circulation is coming into the indoor auditorium seating space of the Preah Suramarit Theatre. However, according to those who visited the theatre at the time before the original design burned down all provided the same information during the oral interviews, that there is no air conditioning inside the auditorium. The air that are coming into the theatre is natural air, but they are not sure how or where the air is coming from since there is no evidence of condenser units and the theatre has no window.

Chaktomuk Conference Hall

Figure 13 Chaktomuk Conference Hall. Photo by Ty Pisith, March 8, 2018.

The Chaktomuk Conference Hall was inaugurated in November 1961, which is one of the first Vann Molyvann's illustrious building originally for hosting public conferences and cultural events that can hold up to 850 people. That hall was renovated back in year 2000 (Ross and Collin 2006). The suspended design gives the impression of the lightness similar to the floating Khmer House along the canal and rivers dating back to the ancient time. The design of the building explicates several homegrown of Khmer elements by bringing them into a modern context. The conference Hall has a triangular concrete structure that is suspended from the beam which had been arragned in a fan shape around one central point (Ross & Collin 2006) (Fig. 13). Vann's design idea is to incorporate bio-climate features such as shading provided by the curved veranda, and by having the building elevate off the ground with open space that functioned as a multi-purpose area and for better ventilation flow in both direction, starting from the ground floor building flowing up toward the back stage (West to East), while ground floor from the back of the building flowing underneath of the stage up towards the seating areas (East to West) (Fig. 14). Underneath the gable roof is the double roof structure that serve as insulation to avoid heat transmission from the sunlight between the two layers of the roof getting inside the building by allowing the airflow through the roof structure (Fig. 15). As for the seating space, there are four main entrances for audience entering or leaving their seats without disturbing other audience during performances. With the four entrances there are two foyers with openable linear windows, those can be used as air ventilation

access (Fig. 16). Another two entrances are accessible form the veranda into the seating area that can help to add more air into theatre during heavy traffic of audiences before and after the show ends. Moreover, another unique design of the theatre is the fan shaped seating arrangement that allow audience to have a full view of the stage in all directions from where they are seating; whether from the center, left or right side, they can all see what is being performed on stage without having to stand up or distracting their neighbors.

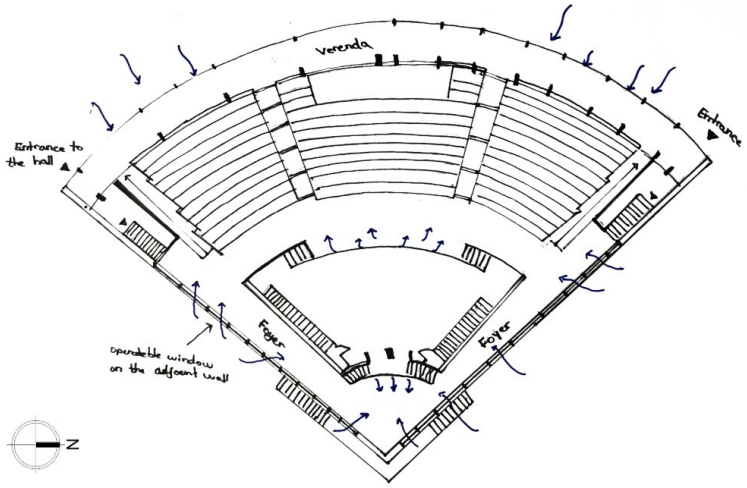

Figure 14 Diagram showing layout plan of Chaktomuk Conference Hall.

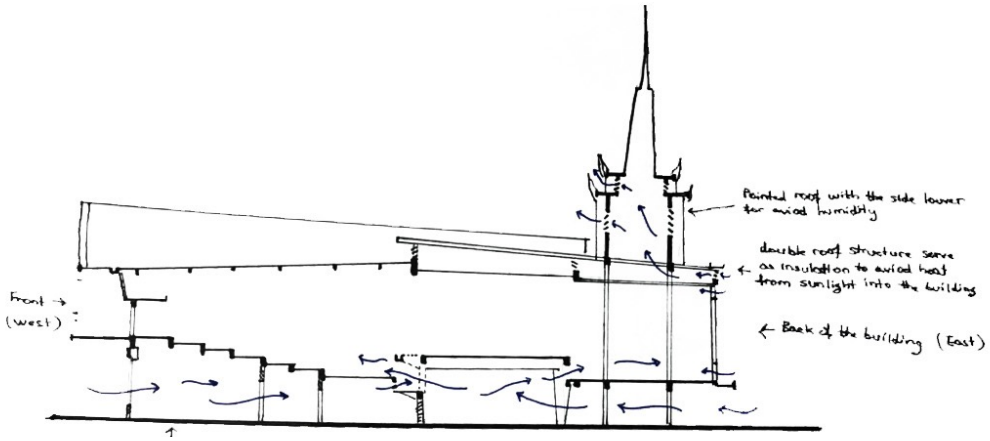

Figure 15 Diagram showing section and air circulation inside the building.

Figure 16 Photos showing from the south elevation foyers with openable linear windows, that can be used as air ventilation access into the building. Photo by Ty Pisith, March 8, 2018.

Tropical Strategies of Vann Molyvann

To sum up, the three buildings; The National Sport Complex, Preah Suramarit National Theatre, and Chaktomuk Conference Hall, are architectural masterpieces that share main features, and some difference which are skillfully designed with intent or rather a purpose.

Main Features of the Three Buildings

The main feature that is prevalent in the three buildings includes a cross ventilation designed throughout the structures. Each of the buildings was 'raised the level of the ground' purposely to enable better ventilation flow from the ground to the upper floor. In particular, The Preah Suramarit Theatre's and The Chaktomuk Conference Hall's upper-level floor of the main space had a linear operatable window along the wall to allow the ventilation flow into the inner space. For the National Sport Complex, the cross ventilation was done through a punched hole beneath a seat, the three buildings also embraced similarity through the indirect sunlight design. The design strategy was purposely employed to allow the sunlight to enter the buildings from the side louver rather than the usual top of the gable rooftops. All the three facilities also used perforated wall which were intended to moderate the air circulation with only a difference in the style of the design.

The Differences amongst the Three Buildings

Unlike the Chaktomuk Conference Hall, the other two buildings incorporated the passive cooling technique though the use of water. Whereas the National Sport Complex main building is surrounded by a pool of water, the Preah Suramrit Theatre has a pool of water in the middle with the purpose being to cool the indoor arena and the building respectively. The Chaktomuk Conference Hall employed a different technique from that of the other two buildings for cooling purposes. The facility used a double roof design which served as insulation to subvert any contact with the sunlight heat transmission hence maintaining it at cool temperatures. The insulation is made possible by allowing air to flow in between the two layers of the building's roof structure. Additionally, both the Chaktomuk Conference Hall and The National Sport Complex differ from the Preah Suramarit Theatre by having shades. The Chaktomuk Conference Hall give shade to the underneath floor, and the upper floor walk-way through the curve veranda while the National Sport Complex give shades to the sidewalk around the main building though its slanted wall.

Although the buildings had a number of differences, all the disparities had a common purpose which was to come up with a bioclimatic design that would enhance the comfort of their occupants at all the time. Each different design was implemented in a manner that would modulate the water, air and sunlight to regulate the temperature within the arena and allow proper ventilation. The National Sport Complex stands out to be unique amongst all the other two by its lack of modern air conditioning systems but at the same time designed in a manner that achieves excellent ventilation. On the other hand, the Preah Suramarit National Theatre has a unique triangular roof made of shutters enabling it to allow, into the hall, fresh air. The Chaktomuk Conference is uniquely elevated above the ground level

besides its double roof structure which particular allows for air ventilation and acting as an insulator respectively.

Lastly, the spectacular designs of the three buildings have shown the very significant strategies dealing with tropical climate by incorporating mainly natural air ventilations and reducing the direct sunlight to the main space of the buildings rather than the use of modernized air conditioners. Although the principles of tropical architecture of Vann Molyvann are very similar to those of the region's vernacular architecture, his strategies were conducted through modern architecture languages imported from none tropical climate zone. Thereby making them points of interest in the study of architecture. The examples could be used as a reference for contemporary architecture in pursuing better sustainable design of the country and perhaps the region.

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