Lessons from traditional architecture: Design for a climatic responsive contemporary house in Thailand

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ABSTRACT: The question posed in this paper is whether traditional Thai houses perform better than a typical contemporary Thai house in creating comfortable internal conditions. And if they do how is it possible for the contemporary house to benefit from the advantages presented in the design of the traditional house in terms of thermal performance while maintaining thermal comfort conditions for its occupants. The thermal performance of both types of buildings is therefore investigated, using a simulation model and based on a selection of thermal performance criteria of local traditional and contemporary house models in Thailand.
The results indicate that improved performance might be achieved by combining selected lessons from the traditional design e.g. improved shading, regional variations in window size related to orientation, and adoption of adjustable ventilation and window openings.

Keywords: traditional architecture, comfort, climatic responsive design, contemporary house, tropical climate, Thailand

1. INTRODUCTION

Contemporary architecture is frequently seen as the example of an internationalism, which eradicates local traditions and transforms the globe into a faceless urban sprawl [1]. It is often forgotten and even ignored that architectural traditions are rich in content, given that they have found the right harmony between the necessities of living, the environment, material resources and ideas on the use of space [2]. Using these criteria, contemporary architecture could take a direction where cultural continuity and adaptability take pride place but also provide guidelines for climate-adapted and sustainable architecture.

However, during the last decades the impact of current socio-economic and cultural changes on traditional environments has become obvious; contemporary design is depending increasingly on mechanically controlled environments in order to maintain comfort, hence increasing energy consumption.

The paper focuses on the comparison between traditional and contemporary house in Thailand by analysing which design characteristics of the traditional house could be adopted in the contemporary house in order to further improve occupants' comfort and minimise energy consumption while considering issues of lifestyle requirements of contemporary living and culture issues which may also influence the housing design and its performance.

2. TRADITIONAL AND CONTEMPORARY HOUSE IN THAILAND

Over the years, people in Thailand have adapted their life to the changes brought by technological developments. The traditional house today could not serve the variety of activities in the same way as the contemporary house, which are cheaper, stronger and more flexible than traditional houses and therefore appear to be more popular than the traditional house. However, modern concrete structures in Thailand reflect little of the traditional wisdom inherited in the old design.

2.1 Design layout and materials

The contemporary house, shown in Figure 1, is constructed with concrete structure and floors, brick walls, and a plasterboard ceiling with 3cm of insulation and concrete tiles on the roof. The windows are single glazed. This is considered typical of houses currently being built in all regions of Thailand.

The traditional Thai house is ideally adapted to its environment. Open high-pitched roof that facilitates air circulation. Open windows and walls in combination with a large central terrace provide ideal ventilation and offer relief from the hot and humid climate. Wide overhanging eaves protect the house from sun and rain. Rainwater runs off the steep roof quickly and falls through the permeable terrace and house floors. The use of wood and bamboo reflects the once abundant forests that provided these materials ubiquitously and cheaply.

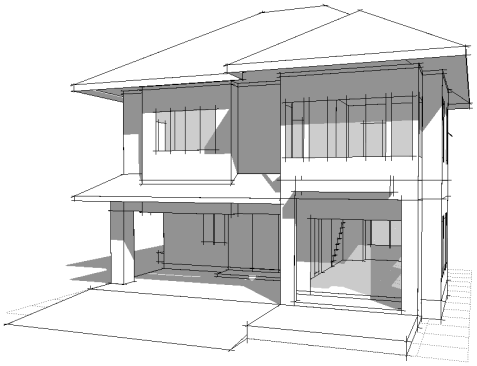

Figure 1: Contemporary House in Thailand (Source: Antarikananda, 2005)

2.2 Comfort

Contemporary houses are seldom designed to consider cooling without the addition of mechanical air conditioning. Indigenous plants and trees are commonly cleared from the site so that almost no shading is available on the site. Existing in a benevolent climate, but where coolness is a sought-after relief, people living in a traditional house move in different parts of the house in order to seek comfort. Contemporary houses are equipped with air conditions and therefore provide comfort to their occupants' standards.

2.3 Energy consumption

The use of artificial microclimates to create comfortable living conditions is indispensable in areas where extreme conditions prevail. The consequence of that, is the appearance of a population which becomes increasingly demanding and less intolerant in matters concerning comfort, and results in high energy consumption which contributes to the deterioration of the environment.

3. METHOD

The thermal performance of traditional and contemporary types of buildings in Thailand is investigated, using a simulation model and based on a selection of thermal performance criteria with a focus on the building form and materials; there is no sophisticated modelling of user responses. The environmental analysis program Ecotect from Square One was used to predict the performance of house designs in different regional climates in Thailand. Three zones of Thailand were selected for this study, from a more comprehensive analysis [3]. Measurements in existing houses in order to verify the simulation results are anticipated to take place as the second stage of the research.

3.1 Comfort Indicators

The cooling loads are significantly higher than the heating loads, with the exception of the traditional house in the south zone, where both heating and cooling loads are relatively small. Therefore the response to the threat of overheating was taken as the primary indicator of the success of the house design in responding to climate. Three indicators of response to overheating are used: (1) duration of overheating, (2) intensity of overheating, measured in degree-hours/year and (3) cooling load, which is an estimate of the useful energy required to keep the internal temperatures within the comfort zone.

3.2 Regional Climates

The simulation exercises were carried out using climatic data from three regions [4]. The southern region is the peninsula bounded by the Andaman Sea on the west, and the South China Sea to the east. The central region is largely a coastal plain, extending from the northern end of the peninsula, to Chai Nat, and includes the capital, Bangkok. The north-eastern region is a high level plateau which borders with Laos to the north and east, and with Cambodia to the south. Climate data from Songklha was used to represent the southern region as humid with high day time temperatures. Bangkok data represented the central region, with lower humidity than the south, but with higher temperatures. The climate of Ubon Ratchathani, with humidity generally lower than both other zones and a wider range of temperatures, represented the north-eastern region. The comfort zone for each region was calculated using the Weather Tool in Ecotect. This attempts to account for acclimatisation by relating the comfort zone to the annual average temperature. Both the southern and the north-eastern regions have comfort zones from 24.5-29.5 degrees C, whilst the hotter central zone has a comfort zone from 25.5-30.5 degrees C.

For the current research four regionally distinct house types are identified [5]. The regional differences can be attributed to climate, resources, technology, culture and beliefs [6]. The traditional houses selected for comparison with the contemporary house in the south, central, and north-east regions of the country are illustrated in Figure 2 to Figure 5. They are constructed almost entirely of wood, with no ceilings, and clay tiled roves. There is no glass in the window apertures. Detailed description is available [7].

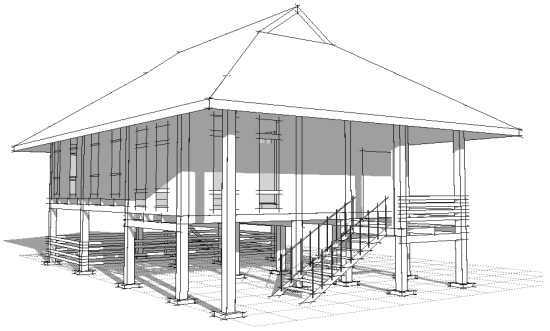

Figure 2: Traditional House, South region of Thailand (Source: Antarikananda, 2005)

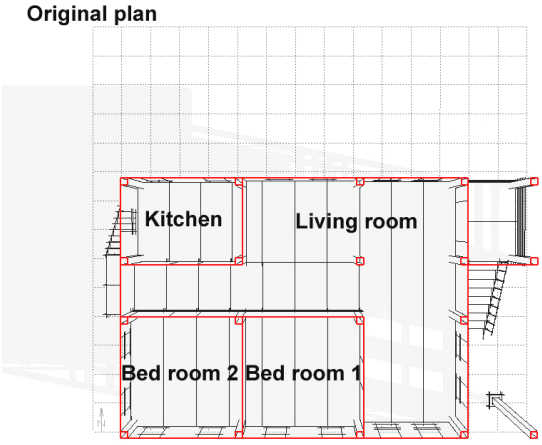

Figure 3: Layout of Traditional House, South region of Thailand (Source: Antarikananda, 2005)

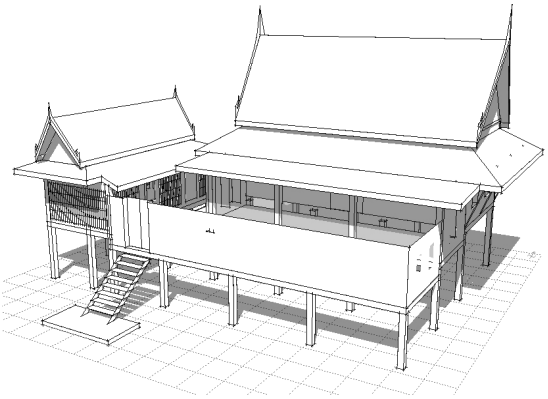

Figure 4: Traditional House, Central region of Thailand (Source: Antarikananda, 2005)

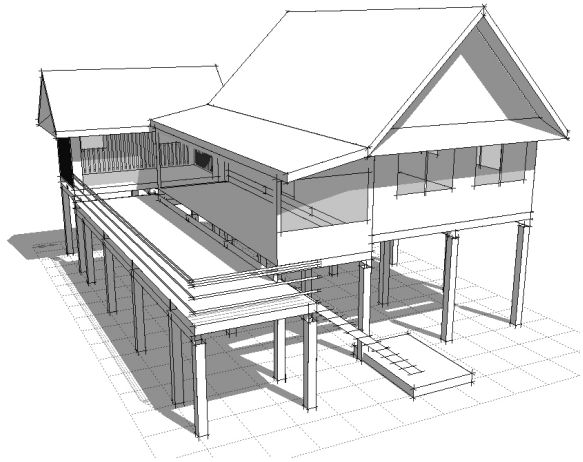

Figure 5: Traditional House, North-east region of Thailand (Source: Antarikananda, 2005)

4. RESULTS

Temperatures in the contemporary house are too high for longer periods than those in the traditional houses in all three regions (Fig. 6). Therefore, if there is no mechanical means of controlling the internal environment, the traditional house will be comfortable for longer periods than the contemporary house in all climatic regions of Thailand. This is probably due to the higher ventilation rates and lower thermal mass in the traditional houses.

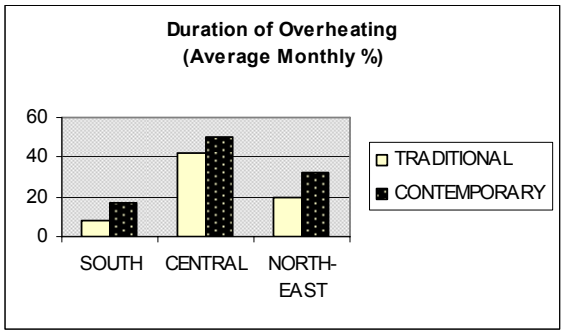

Figure 6: Comparison of the duration of overheating in a Contemporary house and Traditional houses from different climatic zones in Thailand (Source: authors)

In the south and central zones, not only is the duration of overheating greater in the contemporary house, but also the intensity is greater (Fig. 7). The cooling degree-hours in the contemporary house are greater than those in the traditional houses. The difference between the traditional and contemporary designs is particularly marked in the central zone. This might be attributed to the increased solar gain through the larger apertures, the use of glass in the window frames, and the decreased proportion of shading in the contemporary design.

In the north-eastern zone by contrast, although the duration of the overheated period in the contemporary house is longer, the intensity is lower, with the cooling degree-hours in the contemporary house calculated as 53% of those experienced in the traditional house. In this case the contemporary house benefits from the massive construction in a region where night temperatures often drop below the comfort zone, and there is a larger diurnal temperature swing.

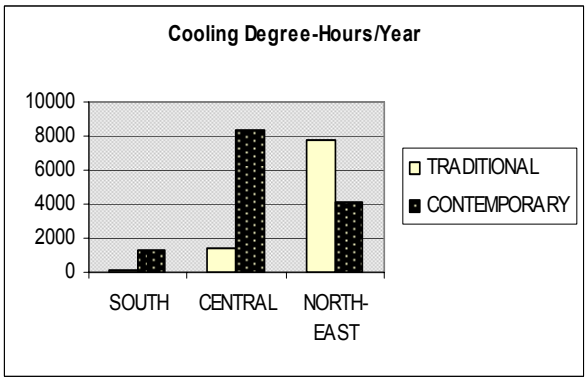

Figure 7: Comparison of the intensity of overheating in a Contemporary house and Traditional houses from different climatic zones in Thailand (Source: Authors)

The cooling load is somewhat lower in the contemporary house than in the traditional houses in the central and north-eastern zones (Fig. 8). The exception here is the south zone where the traditional house cooling load is smaller. The temperatures in the southern zone are more influenced by the proximity of the sea, and it appears that the combination of shade and air movement are almost sufficient to keep internal temperatures within the comfort zone. The southern region traditional house has large, vertical apertures that increase natural ventilation. These are protected from the sun by large roof overhangs. The cooling load is an indicator of the amount of useful energy required to keep the internal temperatures below the upper level of the comfort zone. Hence Figure 8 indicates that, with the exception of the southern zone, the contemporary house will require less energy to achieve comfort, if mechanical cooling systems are installed. The higher ventilation and fabric gains in the traditional houses are the probable cause of their inferior performance with respect to cooling load. A summary of the simulation results for each of the three selected climatic regions is presented below in Table 1.

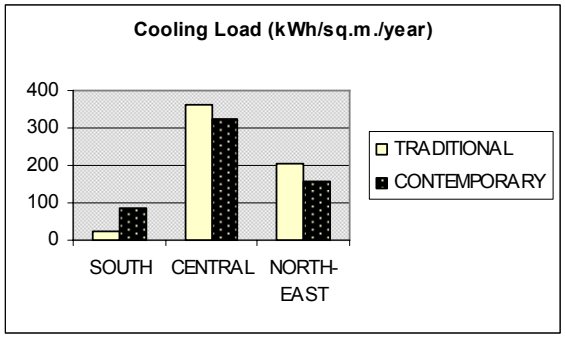

Figure 8: Comparison of cooling loads in a Contemporary house and Traditional houses from different climatic zones in Thailand (Source: Authors)

5. DESIGN RECOMMENDATIONS

As discussed earlier, contemporary design often is becoming increasingly detached from the limitations imposed on it by local climate and the environment. It is the belief of the authors that there is a dynamic relationship that exits between the past and the present and that several features from traditional housing offer potential improvements to the contemporary house designs.

These include improved shading, adjustable openings in the form of windows and ventilators, raised platforms, and variation in the size of windows depending on the climatic region and the orientation.

In the north-east, where there is a more pronounced period when occupants might feel too cold, there may be benefits from incorporating adjustable openings in the building envelope to increase occupant control of ventilation. In the southern region longer roof overhangs are required to increase shading for the contemporary house. In the central region the massive construction of the contemporary house does not appear to offer any advantage in terms of moderating the impact of high ambient temperatures. Houses for the central region would also benefit from improved shading, particularly on the south-west and west facades. The inadequacy of the shading on the west elevation of the typical contemporary house is illustrated in Figure 9.

Table 1: Summary of the simulation results for the contemporary and traditional houses for the selected three climatic regions in Thailand (Source: Authors)

Simulation Models	Discomfort				Total Heating Loads (kWh/year/m²)	Total Cooling Loads (kWh/year/m²)
	Too hot (average%/month)	Too cool (average%/month)	Total Too hot (Degree Hour/Year)	Total Too cool (Degree Hour/Year)		
Traditional house in central region	41.58	4.92	1353	752	54.7	362.99
Contemporary house in central region	50.17	2.92	8308	552	25.4	324.56
Traditional house in north-eastern region	19.5	9.0	7736	366	8.58	206.26
Contemporary house in north-eastern region	32	6.83	4106	587	26.1	157.84
Traditional house in southern region	8.33	2.58	160	627	67.0	23.39
Contemporary house in southern region	16.67	0.58	1325	19	6.04	83.61

In contrast the design shown in Figure 10 achieves much more effective shading. It illustrates the incorporation of a number of recommended improvements in the contemporary house. The house is raised on columns to avoid flood damage and improve the potential for natural ventilation. There are several projections from the central block, which provide short cross-ventilation routes.

Finally a number of roofed verandas have been added which provide additional functional space and shading for the apertures in the walls behind them.

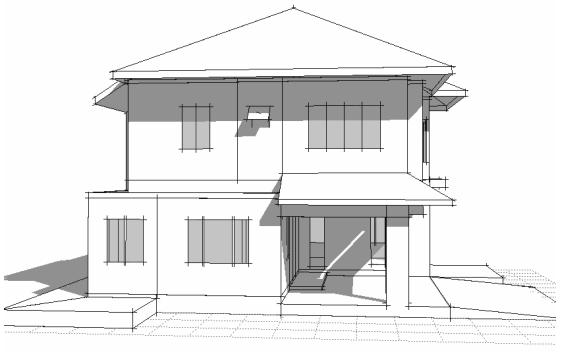

Figure 9: Inadequate shading on west façade of a contemporary house in the central region at 3pm in June (Source: Antarikananda, 2005)

Figure 10: An improved contemporary design featuring additional shading, raised floors and shaded external platforms (Source: Antarikananda, 2005)

6. CONCLUSION

Regional architecture is often neglected which has lead to the loss of the knowledge handed down by the local population on how to create comfortable living environments with limited or no energy consumption.

In the current research, the thermal performance of simulated models of contemporary and traditional houses for three climatic regions of Thailand were compared and analysed.

In the comparative analyses, the simplest indicator of overheating, the duration during which temperatures are too high, provides some evidence to support the proposition that the traditional house designs are superior to the contemporary in providing thermal comfort for all three climatic zones of Thailand selected. This supports the argument that traditional architecture is indeed well adapted to the climatic variations across Thailand, and can provide longer periods of thermal comfort when houses are operating in a purely passive mode.

However the calculation of the cooling degree-hours and the cooling loads reveal a more complex picture. Particularly in the north-east, but also in the central zone, the contemporary house design offers advantages. These advantages would be most apparent in situations where residents wished to install some form of mechanical cooling. This finding is of special interest in the context of changes in the availability of technologies and changing lifestyles and user expectations. These changes are leading to increased heat gains within the home and possibly a reduction in the degree of adaptation to high domestic temperatures.

It is concluded that the traditional housing of Thailand does provide useful indicators of appropriate architectural design responses to climate, particularly in the context of purely passive environmental control. The design of the contemporary house may and should be informed from that of the traditional house, however, issues of lifestyle requirements and culture issues should also be considered in the final design.

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