The integration of traditional and advanced design in the formation of sustainable New Rural Housing solutions.

Van Khai Tran

1Van Lang University, 54 Nguyen khac Nhu, District 1, Ho Chi Minh City, Viet Nam
Email: khaitv@gmail.com

Abstract: Socio-economic growth in Vietnam greatly depends on the new rural development process in this country; the work is considered a strategic position in national development. Thus, the study of the principles of the architectural design of new rural housing solutions in accordance with the New Rural Environment as required by the Vietnam Ministry of Construction has become urgent. Climate change has become a global concern, so the creation of significant impacts by architectural designs to respond to climate change and make the living environment of rural people better is a major demand. Experience has shown that the dogmatic application of current urban-type housing does not reach the requirements of New Rural Housing. This research intends to show that the solutions of the traditional Vietnamese rural house, which retains the advantages of traditional architecture with excellent characteristics that have been challenged over thousands of years, when combined with advanced design methodologies and technologies, will be the appropriate solution for ‘New Rural Housing’.

Key words: Evolutionary, Adaptive, Responsive Architecture.

1. Introduction.

Recently, the Ministry of Construction promulgated the criteria for the design of the New Rural House as a more progressive model than the traditional one. But the dogmatic application of current urban-type housing does not reach the requirements of rural housing of the new era, as it cannot solve the dilemma of combining the traditional lifestyle with the natural surroundings while overcoming the impacts of climate change.

Literature reviews on Vietnamese traditional rural houses show that most of these houses have a good relationship with the surrounding landscape and that the composition of spaces inside and outside is arranged to be flexible, and therefore in harmony with the natural and social context. After thousands of years of evolution, traditional Vietnamese rural houses have learned how to respond to adverse climate conditions and gained valuable experience in climate adaptation. Furthermore, the copying of the urban house type, particularly tube-shaped houses, is causing the traditional rural aesthetic image to disappear.
Reviews on recent design methodologies conclude that recent design methodologies have the capability to respond to a number of requirements of contemporary housing. Firstly, the theories of Evolutionary Housing propose that the house is allowed to develop gradually in quality and quantity, and ‘time’ is regarded as a resource for housing development. Adaptive Architecture solutions show the ability of house structures and architectural components to transition from their initial function, in accordance with the need for new construction in the new developing environment. The application of ‘Transformable Structures’ can adapt their house shape according to changing circumstances, to solve new function demands or even move to new locations.

Vietnamese traditional rural houses have been formed to respond to adverse natural conditions and to collect valued experiences in functional, effective climate adaptation. In recent times of economic and social development, with the challenges of global climate change, the construction of rural houses on these valuable experiences, integrated with advanced design methodologies and technologies, is what it takes to look to New Green Rural housing models in the new era.

2. Definition of the concept of “New Rural Housing”

Based on the general policy of national development, the Vietnam Ministry of Construction adjusted some criteria of rural housing stipulated in Circular 41/2013/TT-BNNPTNT of the Ministry of Agriculture and Rural Development and supplemented additional instructions of implementation under this Circular.

According to the demographic statistics of the state, in 1999 the total population of the whole country was 76,289,573 million people. Of these, 58,361,523 people lived in the countryside. In 2009, the total population was 85,846,977 people, but in spite of the rapid urbanisation, the rural population also rose to 67,200,000 people with smaller household size. This led to a great demand for rural housing.

The Ministry of Construction’s stated main requirements on the solution of “New Rural Housing” was as follows: Ensure the rigidity of 3 parts: Fundament, Frame, Roof. The above-mentioned parts must be made of good quality material and not made of perishable, flammable materials. The tenure of use of residential buildings is from 20 years or more. The housing design must conform to local customs, habits and traditional lifestyle; ensure hygiene requirements; be convenient for daily life; inherit the traditional architecture style; connect in harmony with the natural surroundings; consume less energy; protect against the impact of sunshine, rain, wind and storms which are more likely following the impact of climate change; and resolve the close relationship between the production space, living space in each household.

3. Literature review

3.1. Review of the capability of Vietnamese traditional houses

Hoang Manh Nguyen [1] states that houses in the Northern rural area have evolved and learned how to respond to adverse climate conditions and put together valuable lessons in climate adaptation. Nguyen HM stated: “Surmount the challenges of recent global climate change, building on these valuable experiences and integrating with advanced technologies is what it takes to look to modern green rural housing models.” He also claimed that traditional Vietnamese rural housing has a good relationship with the surrounding landscape, and that the coordination between the inside and the outside is arranged to create a close and flexible environment.

Nguyen Dinh Thi [2] stated that each housing model must be less than 150-200m2 with 2 or 3 stories surrounded by their own private traditional garden, conserving the traditional aesthetic appearance. Na LTH and Park JH [3] emphasize that, generally, a locality’s traditional buildings offer the best examples of appropriate passive-mode design or bioclimatic design. Le Thi Hong Na and Jin-Ho Park cite that learning from Vietnam’s traditional examples, it is important to adopt a design strategy that begins with a design of
the built form by optimizing all the passive-mode strategies appropriate to the climate and ecology of that locality when the basic design of the traditional house and its construction methods give it great flexibility so that extensions to the house can be carried out whenever necessary.

3.2. Review of the concept of Evolutionary Housing

The concept of Evolutionary Housing was introduced in 1985 by Martinez E and Di Lullo R [4] through lectures on Low-cost Housing at the Institute for Housing Studies (IHS) in Rotterdam, The Netherlands as a basis for housing solutions to low-income people. Martinez E explained that when lacking initial investment resources and when initially unable to meet required standards, Evolutionary Housing allows the house to gradually develop in quality and quantity including in area, space and materials. In time, this housing will meet required standards. Both authors conclude that ‘Time’ is regarded as a resource in the projects of low-cost housing development for low-income people.

Arora S (USA) and Saxena S (India) [5] develop the concept of Evolutionary Housing towards applying Bio-climatic principles in order to create architecture and buildings in harmony with nature. Structures and components of the houses can change position, interact flexibly, alter or upgrade.

3.3. Review of the concept of Adaptive Architecture

Schnädelbach H [6] cited that Adaptive Architecture thus has the capability to respond to a number of parameters with time. Time is an integral factor driving adaptation in architecture, thus Adaptive Architecture can be said to be Responsive Architecture evolving with time. Schnädelbach H further clarifies that Adaptive Architecture is concerned with buildings that are specifically designed to adapt (to their environment, to their inhabitants, to objects within them) whether this is automatically or through human intervention [6].

Verma S, Pradeep D [7] state that the environmental changes that occur in a given time, such as a day, can be a constant force of changes that need to occur in an architectural object. This leads to local adaptations to global climactic change occurring over the course of time and creates forces for architectural objects to change over the years in order to survive and sustain themselves. Furthermore, Sushant Verma and Pradeep Devadass explain that Adaptation in architecture is a long-term process that occurs with time and generations, where improvements in technology, economic support and human thought process contribute to the adaptive response.

Kim J J and Rigdon B [8] cite that: For the purpose of conceptual clarity, the life cycle of a building can be categorized into three phases: pre-building, building, and post-building, as shown in Figure 2 which illustrates how these phases are connected, and that the boundaries between them are not obvious. Analyzing the three phases of the building processes in this figure provides a better understanding of how after design, construction, and operation then disposal of a building could be inhibited to cause fewer negative effects to the ecosystem.

![Figure 1](image1.png)

**Figure 1.** (a) Fixed structure, (b) Exposed surface of fixed structures, and (c) Interactive structure.
4. Research Methodology

Integrative studies on the characteristics of the elements of traditional architecture carried out in this research were mainly based on the criteria of “New rural housing” launched by the Vietnam Ministry of Construction which is already the outcome of both qualitative and quantitative research done by state institutions. Quantitative research was further based on the data of demographic projection to provide a view of the large demand for rural housing and the appropriate scale of house models for rural households. Qualitative research was carried out by reviews of the contemporary trend of housing characteristics - sustainable housing and the concepts of Responsive Architecture, Adaptive Housing, and Evolutionary Housing which will provide a main part of the theory of housing design methodology. Qualitative research was also carried out on the traditional house architecture of Vietnam, on buildings that had met the challenges of the local social and natural conditions and survived through thousands of years of history. Therefore, their characteristics could be recognized amongst the most advantageous and suitable solution for the New Rural Houses. Issues of climatic and contextual restraints examined within this method will allow for the theoretical premise and unifying idea to direct the research. The studies will show that the column and truss structure of Northern traditional houses with excellent characteristics holds a rich history of thousands of years in responding to climate change and improving the living environment with better
qualities, including aesthetic appearance. Meanwhile, the structure of the Central and Southern traditional houses, with larger fixed elements, survive in a more favourable climatic conditions.

5. Materials on the current status of Vietnamese traditional rural houses

5.1. Categories of Vietnamese traditional rural houses
The architecture of Vietnamese traditional rural houses depends upon various local constraints including economic, social, religious, aesthetic, climatic, and regulatory. They have taken various spatial and structural forms at different areas over time, each of which leads to decision making at a particular stage in the design process. In an overall view, Vietnamese traditional houses consist of three main categories: Houses built on land, houses built on stilts and a minority of floating houses on the water surface.

5.2. Structural systems of Vietnamese traditional rural houses
Tran Thi Que Ha in the research “The origin and development process of Vietnam traditional houses” at Singapore National University, describes the forms of load-bearing structure systems of Northern, Central and Southern houses built on the land is illustrated in the charts of figure 3 and figure 4.

![Figure 3. Column, truss system of Northern house](image1)

![Figure 4. Column, truss system of Central Vietnam and Southern Vietnam](image2)

Materials, including sketches and illustrations of traditional architecture, are vital pieces of information to help understand practices of the vernacular and traditional. Written research results will also assist in analyzing the climatic and resource limitations, which may have influenced the development of the traditional and environmental architecture that may have affected the rural residential house solutions.

The above materials and reviews show that traditional Vietnamese rural houses have many characteristics suitable to the application of advanced design solutions, the maintenance of the traditional characteristics are not derived from the old-fashioned sense. Vernacular housing space retains the beauty of traditional architecture since these excellent characteristics have been challenged over thousands of years, and should not be constructed temporarily or poorly.
5.3. The main difficulties and failures in the recent development solution of rural houses. The dogmatic application of current urban-type housing does not reach the effect of New Rural Housing. With the northern village-rural areas: people often think of the village gate, banyan trees, temple yard, bamboo ramparts, tree gardens and fish ponds. Now, those scenes are replaced mostly by urban tube house types, therefore requirements arise to resolve the acute problems in urban areas and to protect the natural environment. The recent construction trend of copying the urban housing tube model nationwide have many unsuitable characteristics for the rural environment and landscape, with a width of 4 - 5m, length of 20m, 1-3 floors, mostly in "district towns", poor natural lighting and ventilation. For failure of adequate attention being paid to the unfavorable environmental factors such as hot weather and floods, the trend of building village housing in an urban style does not save energy and contributes to a weak quality of life and architectural aesthetics, affects the rural landscape, and creates an urgent demand for tap water. The traditional source of materials for building traditional houses such as timbers, bamboo-knitted walls or burnt bricks to build walls are no longer abundant, which erodes the folk character. In contrast, the big problem herein is a demand for solutions to ensure a safe environment, especially a clean water source, address the demand for tap water and flood prevention from the climate change phenomena.
In comparison with rural houses which copied the recent urban house types, the traditional rural house of Vietnam is a remarkable option of adaptation to the vernacular climate conditions.

6. Results: Solutions for the New Rural House

6.1. Solution for Space Organisation
The house layout can still follow the traditional plan of 3 or 5 bays: 01 living room and worshiping area; 01 or 02 bedrooms or more, behind the advanced design perspective, it can be changed to be suitable for different types of families, or the existing or new multifunctional circumstances. Each house area should be 150-200m2 built with 2 or 3 stories surrounded by their own private traditional garden.

6.2. Common Technical Solutions
Due to the economic situation of the majority of family farmers, high technology may not yet been applied broadly. Therefore, appropriate and flexible technology, easy construction, using local manpower would be applied popularly. In detail:
- Load bearing structure is rigid frame therefore it should be the load bearing reinforced concrete frame.
- The roof is built in the form of "hard roof" roofing tiles or galvanized steel sheets with insulating layers of corrugated porous or insulating layers of natural leaves.
- The external walls should be made of unbaked brick, the partitions with light materials which can be changed flexibly in order to meet the transformation and renovation of utility requirements, combining the technology to solve the microclimate environment such as energy saving ventilation and natural lighting.
- The sanitation system includes good treatment of domestic wastewater, livestock wastewater and environmental protection.
- Pure rural housing: used for families mainly producing agriculture. This has existed for a long time so when designed it should retain the traditional architectural forms and space, combining the structural system of "stiff frame, hard roof", flexible wall and partition system.
- Type of household combined with family economic activity: with characteristics of a farm besides ensuring living conditions, associated with tree gardens, ponds, outbuilding and workshop.

6.3. Applying Adaptable architecture in the evolutionary process
The Vietnamese government considers that the socio-economic environment of the new rural areas should continue to improve living quality, while also enabling other productive requirements at high speed. So rural houses should have diverse forms that may transform continually. Thus, new rural housing must have the adaptability that has been described partly in the theory of "Evolutionary Housing" in order to meet the requirements of progress and diversity. The Adaptable Architecture includes some important features: Transformability; Mobility; Upgradability.

6.4. Applying the Solution of housing architecture allows flexible transformability
In order to reach the transformability, structure solutions of new rural housing may be:
- The common reinforced concrete skeleton frame is still the suitable main structure.
- Some columns, beams, frames or joints can be demounted, connected, transformed and developed, so there are some connectable, removable steel compositions and joints on the construction elements.
Some components of space may be subdivided or change function. The kitchen, bathroom and toilet sections can be removed partly or upgraded, so it should use the prefabricated assembly solutions.

Not arrange the column network too thick to create space inside in order to change the space

The structural and construction members are removable to create efficient ventilation and lighting.

The dimension of the structural and architectural components should be modularized for changing those components easily, especially the inner partitions. From modularization, it is also easy to establish a market for trading and exchanging the components mentioned above, while at the same time being easy to replace and possibly refurbished, minimizing demolition-causing debris. The modularization of construction members and space is not new; it comes from the application of construction rules which existed long ago in traditional architecture such as the application of the "storey rod" which was introduced widely.

![Figure 9: The modularization of construction members and space comes from the application of construction rules which exists long time ago in traditional architecture with demountable connections.](image)

6.5. Advantages of the solution of mobile housing
The architecture allowing the change of construction location was applied long ago through the nomad tent. Its advantages are that it:

- Contributes to environmental protection when avoiding being demolished leaving garbage pollution.
- Easily meets the requirements of a keepers’ hut at farm planning change, clearance or road extension...
- Responds to climate change circumstances, during floods it is possible to relocate to higher ground or float on the water’s surface through some simple techniques mentioned in the following item.

The solution of a stiff frame structure, not using clamped joints with foundations buried deeply but using coupler joints on concrete or stone bases (typically, the form of traditional columns put on field stone bases). The above mentioned solution meets the requirement of movement when it is necessary to change construction location due to the movement of road boundary due to flooded ground or planning changes. In environment of new rural housing, it can be can applied even for multi-floored housing. If necessary, the houses can be relocated by the so called "folk lamp genies" who can move the buildings with common technologies without demolition

6.6. Architecture solutions for mobile housing
Solution of housing on stilts built on the ground or in a flooded area: This solution is the combination of the stilt house form of the Southeast Asian nations including Vietnam and five principles for designing
house on stilts of Le Corbusier. In the context of climate change occurrence, the ability to live with the water is great. The main structural system of Neo Rural house should be a rigid frame placed on a classical type base or one that can be removed from the foundation.

**Figure 10.** The main structural system of the Neo Rural House should follow the traditional house to be a rigid frame placed on a classical type base and connected by hinged structure.

6.7. Solutions creating effective energy saving

The application of advanced but simple technologies, matching with the economic ability of most farmer families to create effective energy saving mainly in two areas of lighting and ventilation, is feasible and so should be applied. The transmission of light deep into the house can be made with the use of reflective surfaces, such as mirrors put on the louvers to shield the direct sun against radiation, which then shines on the ceiling. The matte painted ceiling will disperse light in a scattering way deep into the house; this avoids the direct radiation causing glare and heat. The reflective surfaces can change the incline angle by the mechanisms of manual or automatic control in order to transmit light in the desired direction. It is possible to guide the sunlight into the pipe and transmit it by reflecting with the light guiding pipe wall. The use of Laser Cut Panel (LCP) is recommended to allow the light to be transmitted in a straight line, avoiding losses of light intensity due to many times of reflection.

**Figure 11.** Ventilation & light transmission. **Figure 12:** Light transmission dispersed through water tank combined tube

The ventilation solutions are already presented by many authors, under two key principles: (1) Blowing straight, especially ventilating across the room, and (2) application of the stack effect to suck the airflow automatically to the top of the house or front door. The patio or staircases are effective in sucking the
airflow up. The structural requirements of some architectural elements like the louvers or ceiling, partitions and mobile floor doors must be flexible for the guidance of airflow as this solution is again related to the theories of Transformable Architecture.

7. Discussion
To sum up, the design of a New Rural House for Vietnam is a remarkable solution of evolution and adaption of space and construction elements to specific natural conditions in the climate change era which potentially could be implemented into architecture of the new era. Choice of flexible transformable structural systems, construction details and application of materials impacts on sustainable development and economically beneficial selection.

8. Conclusion
The Vietnamese traditional folk house has many advantages in accordance with the view of Evolutionary Architecture and Adaptive Architecture; mainly, that it is possible to transform more flexibly than some stereotypical design styles of urban housing. The continuing promotion of Vietnamese traditional characteristics in order to qualify for the standard of a New Rural House is not only to preserve the old image, especially when combining with the new advanced construction technology system. With all the benefits that an Evolutionary and Adaptive rural house could bring, it should be considered as a solution to address related social issues such as the increasing demand for rural residential houses and natural challenges such as environmental problems and the negative impacts of climate change. It is recommended that the rural resident community and the local authorities need to give stronger attention to the integration of traditional and advanced design solutions for the Neo Rural house.

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