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BIOCLIMATIC ARCHITECTURE, A SENSIBLE AND LOGICAL APPROACH TOWARDS THE FUTURE OF BUILDING DEVELOPMENT

BY

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Abstract. The modern world building scene tends to depend more and more on the economical climate as well as the geographical climate itself, as none of the major players in the construction game can afford to ignore current conditions and dismiss logical solutions that can drastically cut the impact on the environment as well as the exploitation costs. The present paper will provide the information needed to understand the bioclimatic architecture concept, as well as describe a few examples of such approaches noted by modern architecture and inspired by vernacular manifestations that occur in different parts of the world. Different by shape but practically identical in the way they function, these buildings help us to understand the logic and wisdom of the place they were born in. If nothing more, alternatives must be taken into consideration by the power of example, as the erratic and mostly intrusive conventional building rhythm cannot be the one we guide our future by. Taking care of the environment and listening to what it has to say will eventually result in the environment taking care of you and providing a comfortable sustainable and energy efficient living environment.

Key words: bioclimatic architecture; sustainable building; energy efficient building.

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1. Introduction

The bioclimatic architecture concept is far from being a new one, as many traditional architecture styles work according to bioclimatic principles. It was not long ago when mechanized air conditioning was rare and expensive, and still is for many places today.

Examples of traditional architecture working in this manner are often vernacular archetypes, such as the Southern oriented windows and insulating blind Northern walls. As a random example, Spanish villages near Andalusía are nestled into South facing slopes, using materials with thermal mass (such as adobe) with an earth coating of lime on walls, creating a stable indoor microclimate. Depending on the actual climate, these manifestations differ but work on the same principle: a design process that takes more time but also understands the need to observe study and take full advantage of the building site, offering simple cheap local solutions to problems that, if ignored, can prove to be a major impediment in healthy, energy efficient living.

In short, bioclimatic architecture has a connection to Nature, as building designs take into account climate and environmental conditions to help achieve optimal thermal comfort inside. It deals with design and architectural elements, avoiding complete dependence on mechanical systems, which are regarded as support. A good example of this is using natural ventilation as well as taking advantage of the sun's, earth and wind's energy providing potential. A nonconventional approach, it still struggles with the common preconceptions and lack of trust towards alternative energy and green design methods.

2. Bioclimatic Principles

In order for this type of project to be a success, certain site characteristics must be taken into consideration before beginning the design process, among which climate, vegetation, topography and geology of the soil are on the top of the list. The main goal this type of building aims to achieve is to minimize the energy needs of the building and to create a more comfortable environment by improving hydro-thermal and acoustic insulation of the structure as well as providing a healthy amount of natural light. In addition, special attention is paid to respect the existing landscape and integrate the building within it.

One of the crucial elements that can establish the success of a bioclimatic designed environment is *natural ventilation* and the way it serves every room in the building, using planted/shaded surfaces to provide cool air intakes which is later disposed of when becoming hot through vents placed in the superior part of the elevation (Fig. 1).

This issue needs to be taken into consideration weather a small or big building is concerned, as a major factor in reducing energy consumption as well as the main cause for health and comfort problems that may occur in a poor lit and ventilated inside space. The natural ventilation and light intake of the space go hand in hand and can be easily controlled and optimized if proper orientation and geometry is provided. In the Northern hemisphere the preferred orientation of the glazed surfaces of buildings is South, a constant source of natural light.

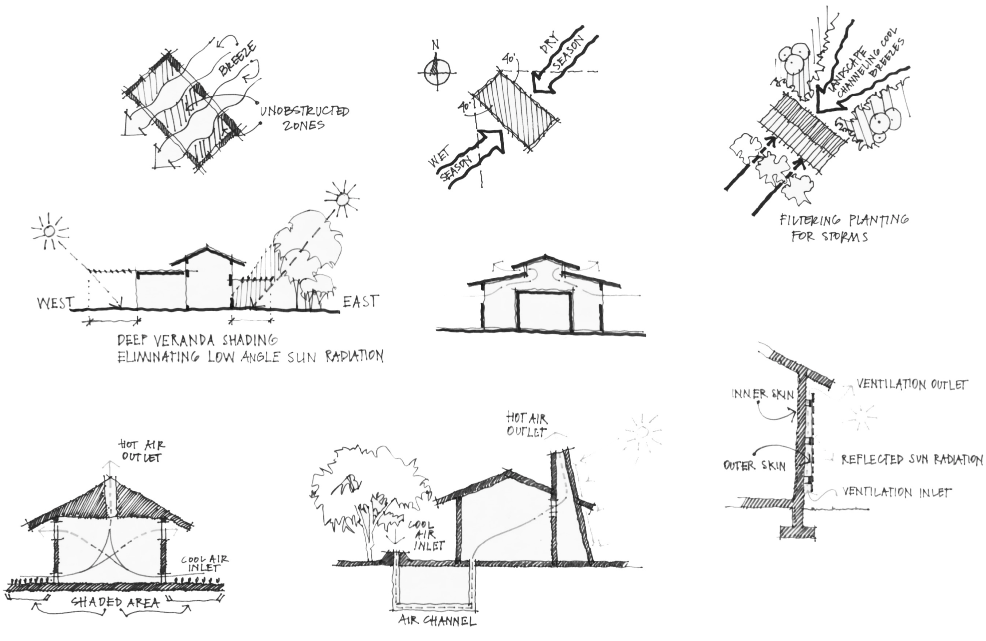

Fig. 1 – Passive bioclimatic architecture principles.

"The back of the house" should always be North oriented, with as less insulation breaches as possible (windows and doors) and intake vents should be positioned in shaded planted perimeters, mostly to the South-East. If this simple scheme is respected, energy consumption will drop heavily, as the naturally acclimatized interior space will use inertia provided by the mass of the envelope, the need for mechanized ventilation and air conditioning thus becoming minimal.

The smart use of *planted perimeters* in the close proximity of the building is a major bioclimatic design factor that can be best addressed when building outside urban overpopulated centers. In the case of tall buildings placed in dense urban building areas, moderately deep loggia can be planted providing a natural shield against the powerful summer sun as well as freshening up the natural airflow (Fig. 2).

Shading devices will be designed for the East façade, as well as bigger more dense such devices for the West façade. Additional solar energy intakes will be provided *via* multi story atriums that radiate heat in the cold season and can be closed during the summer, avoiding the greenhouse effect.

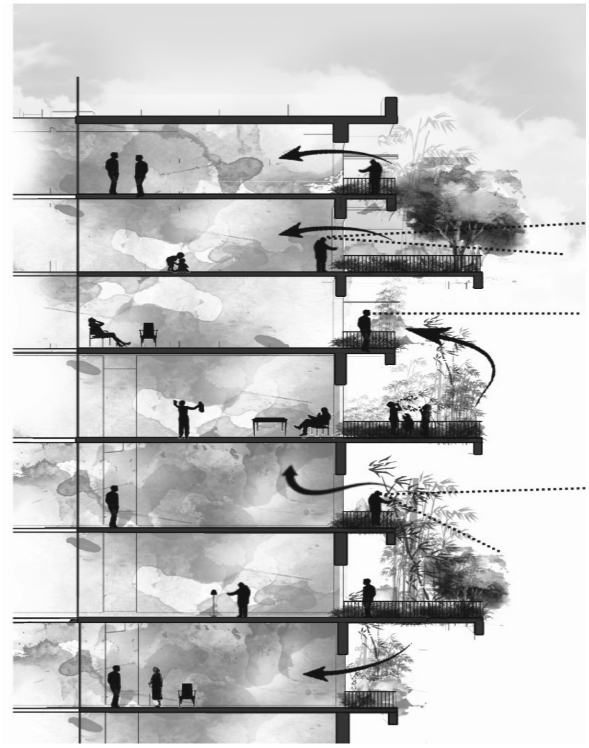

Fig. 2 – Landscaped sky gardens.

The so called "landscaped sky gardens" also act as a green shield for the dust and rain, placed in an alternative depth pattern that offers double height spacing between them, offering clear sky visibility.

The form factor is another decisive aspect to take in consideration when designing in a bioclimatic manner, especially when referring to tall buildings. The plan takes shape in close connection with the site, orienting its living spaces to the South and buffer zones (kitchens, bathrooms, storage and other technical spaces) to the North. Surroundings must be studied and anticipated, as the elevation of the buildings' volumetric shape should think of future buildings and their geometrical characteristics, as noted in the general urban plan. This will assure continuity of the natural light and ventilation advantages, as well as reduction of urban heat isles so commonly met in overdeveloped urban areas. The movement of the sun, natural green surroundings and wind charts will dictate the way the exterior image develops, with carefully placed openings, smart shading façades and green roofs, irregular floor patterns and well placed inclined surfaces that may facilitate the use of solar and photovoltaic panels (Fig. 3).

Fig. 3 – Bioclimatic Architecture volumetry.

One of the main advantages of this unconventional architectural approach is that it’s not conditioned by the scale of the designed building. The simple logical set of ground rules are applicable to all new designs as well as some rehabilitation cases, involving less exploitation cost and requiring time consuming planning that must be done using pluridisciplinary teams of planners and scientists, as well as architects and engineers.

Bioclimatic architecture involves looking at the big picture, shrinking the scale of the observer’s perception over the construction site and resolving core problems in order to allow such manifestations to evolve naturally.

3. Examples

The bioclimatic solutions regarding small constructions are more and more taken into consideration but only concentrate on solving environmental and energy efficiency issues on a smaller individual lot scale. The main issue remains a smart solution that applies nature inspired principles into the high-density urban centers, transforming heavily built masses into healthy evolving working and living environments. For this reason, the two examples presented in the following section of this paper address solutions to these challenges, applying bioclimatic concepts to a larger scale.

3.1. The Eastgate Mid-Rise in Harare, Zimbabwe

Another notable concept developed from the bioclimatic architecture basic principles is called *bio mimicry*, and refers to drawing inspiration from natural structures, thus resolving eco-passive energy saving systems.

The Eastgate building in Harare, Zimbabwe is a perfect example for such an approach, as its' overall shape and planimetric solution is based on a nature inspired ventilation system. Architect Mick Pearce and the Arup Associates engineering team decide to build a mid-rise with no mechanical air conditioning, and instead take the time to design a termite-inspired ventilation system that keeps the building cool because of simple physical properties of air density at different temperatures that force air through multiple smaller spaces.

The model of the twin structures is drawn directly from the self-cooling mounds of *Macrotermes michaelseni* (Fig. 4), termites that maintain the temperature inside their nest to within one degree of 31°C, day and night, while the external temperature varies between 3°C and 42°C. Eastgate uses only 10% of the energy of a conventional building its size and saved 3.5 million in air conditioning costs in the first five years, and has rents that are 20% lower than any newer buildings that were developed later on.

Fig. 4 – Eastgate apartment and office building volumetric analogy.

Studies are made to explain the building principles of the termites, as it could help architects and engineers understand exactly how the tunnels and air conduits manage to exchange gases, maintain temperature, and regulate humidity. The designs may provide a blueprint for self-regulating human buildings.

A series of previously mentioned principles are taken into consideration, like the stack effect that draws the air from the atrium towards the outside of the building, around the glass canopy that covers it, or the deep planted overhang on the Northern façade (which in this hemisphere is the constantly sun-bathed one), as well as solar panels for hot water heaters.

Air is drawn from the lower levels and is sucked out through the natural exhaust that serves each office building, as heat energy is absorbed by chimneys to improve the stack effect (the movement of air into and out of buildings, chimneys, flue gas stacks, or other containers, and is driven by buoyancy that occurs due to a difference in indoor-to-outdoor air density resulting from temperature and moisture differences).

3.2. Menara Mesiniaga Mid-Rise (IBM Building) in Subang Jaya Selangor, Malaysia

The Menara Mesiniaga (Fig. 5) is the headquarters for IBM in Subtang Jaya near Kuala Lumpur. It took architect Ken Yeang two years to design the 63 m high building and another two years to build it, but the result stands as a

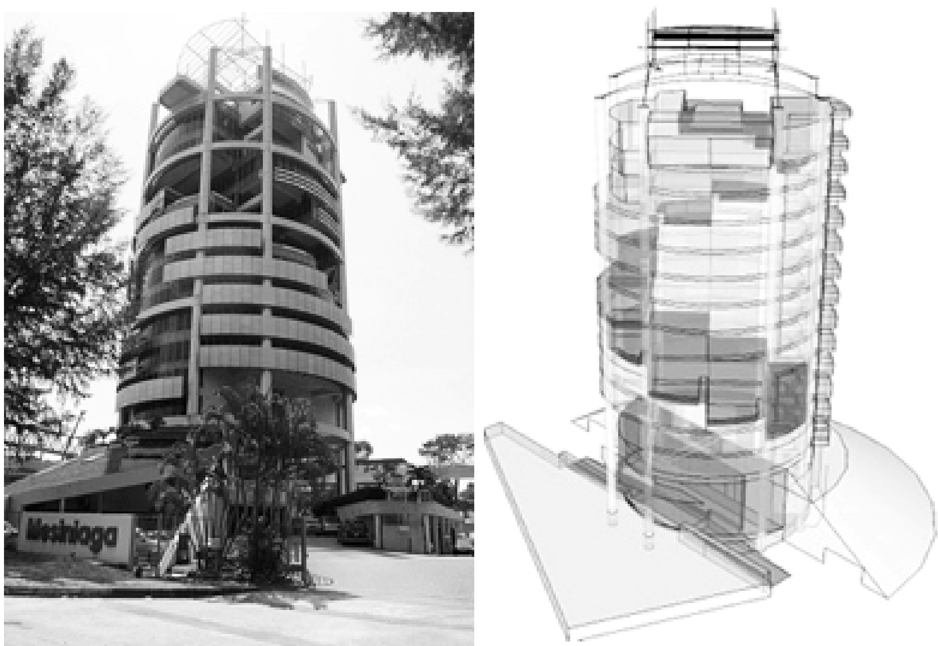

Fig. 5 – Menara Mesiniaga IBM Building in Subang Jaya Selangor, Malaysia.

statement for bioclimatic architecture principles, using traditional Malaysian building models and takes into consideration the relationship that exists between buildings, landscape and climate.

The 15 floor circular structure utilizes a series of main ideas applied in the concept phase of the project, like sky gardens, spiraling vertical landscape, recessed and shaded windows to the East and West as well as curtain wall glazing on the North and South, the most favourable orientation in this tropical climate. The horizontal blueprint also deals with distributing the functions rather unconventionally, using technical functions like toilets (usually placed in the core of the building) to provide shading by placing them on the heavily lit façades, while offices have full-height sliding doors that allow access in the spiral balconies and also allow cool fresh air to come inside the working space. The building's core is naturally ventilated and uses the stack effect to eliminate heated air from the interior spaces.

The trussed steel + aluminum sunroof also incorporates solar panels that power the building. The Menara Mesiniaga is the epitome of building design that reflects climate characteristics specific to the location of the building.

4. Conclusions

The future of the world-wide building scene is shaping up to be further and further away from the conventional one we used to take for granted, and instead is shifting towards groundbreaking concepts like smart cities and sustainable living. Neither of these alternatives won't become anything other than modern utopia if logic, measure and respect for the hosting environment won't act as the major guidelines for future architecture evolution.

Bioclimatic architecture is but a small branch of energy efficient and environment-friendly manifestations and, as important and versatile as it may seem, it won't have any notable effect if a larger scale plan isn't applied in urban areas, resolving more than just small, individual proximity challenges. A bigger scale means more planning effort and correlation between various pluridisciplinary teams that can correctly asses situations, identify problems and try to come up with solutions that could resolve them in a smart durable way. And the only way to do that is by paying attention to our surroundings and learning to respectfully use them to our advantage or better yet, the only way we can build a future is not forgetting the reasons behind any gesture, may it be architectural or otherwise. If logic and common sense are employed, sustainable solutions will occur and living standards will improve.

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ARHITECTURA BIOCLIMATICĂ, O ABORDARE LOGICĂ ŞI SENSIBILĂ A VIITORULUI DEZVOLTĂRII IMOBILIARE

(Rezumat)

Scena modernă a construcţiilor depinde tot mai mult de climatul economic precar dar şi de climatul în sine, iar dezvoltatorii puternici nu îşi mai permit să ignore criterii simple şi logice care le-ar putea reduce drastic cheltuielile de exploatare a investiţiilor şi, nu în ultimul rând, care ar reduce semnificativ impactul distructiv asupra mediului-gazdă. Această lucrare va furniza informaţia necesară înţelegerii conceptului de arhitectură bioclimatică, punctând în acelaşi timp câteva exemple de manifestare a acestuia în arhitectura modernă, exemple inspirate invariabil din arhitectura vernaculară specifică diverselor părţi ale Lumii. Diferite ca formă dar identice în modul lor de funcţionare, aceste clădiri ne ajută să înţelegem logica şi înţelepciunea locului în care s-au născut. Pentru ca modul în care alegem să construim să înceteze a fi intrusiv şi haotic, alternativele neconvenţionale trebuie luate în considerare şi mai mult, trebuie înţelese ca direcţii determinante ale soluţiilor viabile ale viitorului.