"Sun and Sense" 2008
7th "Solar Energy in Architecture and Urban Planning" Conference
Berlin 11/14 March 2008

"**Bioclimatic Housing "** *innovative design for warm climates*

Presentation ***Francesca Sartogo***
12th March 9.00/9.30

The book ***"Bioclimatic Housing"*** arrives at the right moment, when the actual *Climate Change* put on the table the important responsibility to redefine **concepts and principles of the City design.** It is always more and more difficult to ensure the standard urban comfort, that our society has reached in the last century, without compromise the future generations.
The City is a complex organism, is not only buildings, roads, squares and gardens, is more than that, she is the mirror of the real citizens life and where everyone tell his history. Is not designed, but it grows homoeopathically during times physiological very slow.
Looking back at our urban studies, it appears evident how the **design** of the **city** was never a **chance effect,** but a precise result of the relationship between a system of rules, land division, building aggregation and road network, strictly connected with the climatic conditions and solar orientation". City was an organism, a compact aggregation, iso - oriented. polycentric, within an organized hierarchy of gravitation nodes, flexibility, accessibility, safety, and in a circular cycle of its metabolism.
Some important planning **"***myths"* of our century, as that of *zoning, mobility*, high *technology* and the *macroplant* have perhaps made us forget the original structure of the city made of parts as scalar sub-systems of strongly interrelated organisms. All this has proliferated in an unlimited growth often without sufficient interrelations and in contrast with the surrounding environment. The city has become a collection of objects, no longer an "organism", but moreover, its communication is a conversation proper of "**dead language"** between specialists. We are losing the **structure**, the **grammar** and the **syntax** of the formative basis that generated the city itself, its *cultural roots* settled in the *long formative process in continuity with the Community* that lives, uses, and renders it vital. **History, climate, and typology** are the important matrixes, for the Architectural and Urban ecological language.
The Community builds its houses with the millenary experience of the other houses that were built in the same cultural area using the construction modality and methodology of the individual artisans and types of building materials that were suitable to the **geomorphology**, and to the **climatic conditions** of the area. This *"spontaneous conscience"* recognises the great role of the **sun,** the **water**, and the **wind** conditions. The city and its buildings are perfectly coherent and consequent, in the formal explications of their components, to the environmental conditions; they are born together with the **location** and its **microclimate**. The realized building is the global synthesis of the *"ratio, firmitas and venustas*" of *Vitruvius*, (*1° cent b.C*) of its own "*concept of house*" reached at the moment of its construction, as the expression of all the experiences matured in preceding periods and as a matrix for those that follow. A fundamental characteristic is the *flexibility* of its behaviour, which codifies the typological process of the building and also allows it to place itself in organic sequences of building types, of concepts of houses and in a system of connections between them.
The book "*Bioclimatic Housing – innovative design for warm climate"- Earthscan London 2008* is the result of the work of the *"International Cooling Group*" from Iran, Malesia, Australia, Japan and Italy under the auspices of a 5 year IEA/SHC program on "Solar Sustainable Housing";

Today the progressive ***"changing of climate"*** force us to redefine concepts and principles of sustainable and bioclimatic design. During the recent years, the concept of bioclimatic house has evolved to what can now be considered a *"sustainable housing"*

Currently sustainable housing appears to place emphasis on *"energy as the main environmental impact that should be reduced".* Un till now, such housing, in a advanced north European theoretical and applied research, achieved this performance, primarily by reducing heat losses through *compact building form, thick insulation* and *ventilated heat recovery*.

If all that can be appropriate for ***Northern climate***, for any other context of ***Southern warm climates,*** a different configuration of these parameters has to be achieved in designing "*Solar Sustainable Housing*".

On ***Northern Latitudes***, where *"heating is the dominant requirement"* following strategies are effective: *Low surface* to volume ratio; maximising *solar gain; r*eduction of the surface area *facing north, or exposed to prevailing wind; insulation* of building envelope; c*ontrol of ventilation* and infiltration; use of *draught lobbies* to separate heated spaces from the unheated spaces and from the outside; *location* of the entrance door away from *prevailing wind*; use "buffer spaces" on northern or exposed facades, unheated conservatories of *"sunspaces" on the south*.

On ***Southern Latitudes****,* where *"cooling" is the dominant need* following strategies may apply: M*inimising* solar gain; r*eduction* of the surface area *facing south*; provision of overhangs, arcades, shutters and canopies to *shade building envelope; u*se of *ventilated walls and roofs*; i*nsulation* of building envelope, *particularly the roof; c*ontrol of *ventilation*; provision of *solar chimneys* to encourage stack ventilation; location of *openings on shaded side of building or so as to catch prevailing winds; u*se "*buffer spaces" on southern facades; u*se of strategy of *passive cooling system:* ventilation, night-sky radiation, evaporative cooling; use of *"courtyards"* to form *reservoir of cool air* close to building and *introduce daylight* to deep building open spaces and open *to prevailing wind.*

For an efficient and thermal comfort of buildings in warm climates, importance has to be given to *summer cooling* more than *winter heating* or in the some entity, while the role of *natural ventilation and day lighting* become fundamental. An important issue assumes the *"bioclimatic building form"* and the *relationship between buildings and the external spaces* in a different scale organization from the *building* to the *district* and the *City form as a hole.*

The underlying principle behind climate responsive design is understanding the climatic parameters in which the building is situated. Climate, by definition, is related to the atmospheric conditions of temperature, humidity, wind, vegetation and light specific to a geographical location. Within this location, a series of climate conditions can be found. These can be categorized into three levels:

1) there are the ***global conditions*** of the Region created by *dominant geographical features* of *land, sea, sun and air.*

2) these are modified by ***local conditions*** that are dependent upon **dominant features** of *water, topography* and *vegetation*.

3)there are the ***site conditions*** and ***building context***, which are an ***interaction of local conditions and the building***. These three levels of climatic conditions combine to create a *complex inter-relationship between both macro and microclimatic conditions*.

This *complex interrelationship* is what designers have to deal with to produce a building design that is both **functional and comfortable for the climate in which it is situated.** This becomes a ***complex task*** because of the nature of the ever-changing and unpredictable environmental patterns, associated with *different environmental zones throughout the world*.

Bioclimatic Housing

Innovative deigns for warm climates
By Richard Hyde

Organization of the book:

PART I

REDEFINING BIOCLIMATIC HOUSING

PART II

LOCATION, CLIMATE TYPES AND BUILDING RESPONSE

PART III

PRINCIPLES, ELEMENTS AND TECHNOLOGIES

Chapter 3 Mediterranean:

"What is Mediterranean? Thousands of things together. Not a landscape but innumerable landscapes. Not a sea but a sequence of seas. Not a civilization but a set of civilizations build side by side. The orographic and climatic characteristics of the Mediterranean originate from an historical complex and geopolitical evolution that left us important common historical and cultural roots. 'The fundamental unifying basis of the Mediterranean area is the "climate", which brings landscapes and societies ... closer together' (Braudel, 1987).

The **Ecocity project** is situated in the "Umbria Region" the green heart of Italy, on the Arno-Chiana-Tevere River system, and is surrounded by important regions such as Toscana, Marche and Lazio, organized on three valleys, with its characteristics of a specialized local economy.
Following and the results of the *Citizens' Community Planning"*, for the "*Umbertide Urban design"* the eco-city concepts agreement were established, with the "*City as a Renewable Energies Power Station"*, *Car Free City, Bioclimatic Comfort City, Cultural Identity and Social Diversity*. The site analysis originates from the philosophy regarding the "*studies for the city"* that has represented the Italian contribution, from the year '50 on, to the resumption of the historical centers. This recognized the city and the territory as a *long-life holistic organism typology* in a constant evolution process, in *use, technology and form*. As a logical continuation of this philosophy, the project promotes the use, reuse and reinvigoration of cultural heritage, and supports continuity of the urban cultural identity at different levels. *History, microclimate urban grain and building typology* are the main matrixes for urban design of the City.
The site, as the last available development area of the city, does not present the most suitable climatic condition. The project worked deeply to gain "*maximum comfort - cooling the City"* from the existing microclimate. The *"citizen's well being"* target aims to transform the area through a series of urban measures in order to obtain *solar bioclimatic benefits, the mitigation of emissions and the control of the air, water and noise*, that has been called ***"urban comfort"*** and assumed as the *principal motivation* for *urban design* and for the *new sustainable transport structure*. The first objective was to build the "*bearing skeleton"* of the urban structure by the ventilation oriented main axis, coming from the hillside over the river, in strict accordance with the existing city's *oriented frame*. Consequently the *"Bioclimatic Principal Spine"* **tunnels the wind** from the river park, from the south, to the railway station and the ninth century city. The *"Historical Bioclimatic Spine"* tunnels the wind from the new urban area A to the ancient *Borgo Minore*, and the other two remaining "wind corridors" run from the area B through the existing oriented roads and the modern City. Microclimates characteristics are responsive to urban texture and building typologies. The urban texture is a system of buildings aggregated around a *common external "corte".* derived from the ancient *"Roman domus"*. The alternance of *form and function* of this external space is organized depending on the position of the site, in correspondence of the pedestrian main *wind axis* or to the secondary alignments of the *"edible gardens"* in two different *"urban texture typologies"*: The first organized in *"Case Corti - Atrium blocks"* and the second in "*Case Corti - Atrium and Peristilium blocks*"; each with three different "*building typologies"*. Unlike *"conventional urban planning",* structured along *roads for cars*, this project, almost completely "*car free*", is organized according to bioclimatic wind tunnel axis, overlapped by pedestrian and cycling paths. *Alternative mobility* is the "*real core"* of the urban renewal project; in fact it provides the " *main axis of the urban structure design"* for both pedestrian and cycling street circulation framework and the *alternation of the private, semi-public and public open spaces*, as the*"urban green salotto"* where the comfort and the aesthetic quality have been optimized. The use of *green zones, ponds, brooks and canals* improve the conditions of the local microclimate and to reduce the energy demand of the buildings.
The shape and configuration of both the buildings and the public and private open spaces derives directly from ventilation requirements; in fact, the disposition of *each courtyard* and of the *surrounding blocks*, and the *selection of their heights,* depend upon wind corridors. In this way, it is possible to guarantee a *satisfactory degree of wind penetration* in summertime. The whole project has been tested and improved through continuous fluid dynamic software simulations (Fluent) calculating speed and pressure, in order to determine the *courtyard shape* and the *bioclimatic corridors in order to obtain an optimized disposition of the single buildings and to create sufficient and comfortable ventilation for both external and internal areas*. At the "*building level*," the use of the stack effect, integrated with a convective loop system and with a series of chimneys, in order to realize a system of cooling and ventilation in a good microclimate and adequate indoor conditions.

Total result: *at building level,* the solar sustainable housing *energy target,* has reached the Category A, with a *30kWhm2/year*, Category A Plus, with a *20 to 15kWh/m2/year* referred *to* the *Italian Casa Clima concepts*. *At urban level*, the contribution of the "*local biomass production"* organizes the *urban district heating plant,* designed by citizens and Ecocity experts, involved in a local participation process, sized for a thermal energy demand of 679.160 kWh/y. Local renewable energies, biomass, wind and solar energy contribute to the *final energy saving* of **75 %** and to the *reduction of* **73%** *of the CO2 emission***,** in a *very advanced scenario,* compared to the existing Italian standards.

Chapter 7 **Brisbane**: ***Subtropical Climate***

Richard Hyde

The success of a building's natural ventilation performance, particularly inthe tropics, is related to the thermal performance of the building's construction, materials and wind interactions around the building's façades.
To ensure that this occurs, solutions must look at whether the construction materials and form of the building will enhance natural ventilation and control solar heat gain. In order to enhance these naturally occurring breezes, it is imperative to site the building to capture the prevailing breezes and ensure that the location does not restrict the airflow to other buildings within the site or create wind shadows.

PRINCIPLES, CONCEPTS AND TERMS

The basic principles, concepts and terms for the project are outlined as follows:

• ***Heat sink***: an area of the building or site that absorbs and stores solar heat through its mass and which continues to re-radiate to the immediate environment even after the solar load is removed.

• ***Reverse brick veneer*****:** this form of construction was used in the walls and comprises lightweight cladding and insulation on the outside surface of the wall and masonry on the inside. It is ideal for skin-loaded buildings, such as those found in warm and hot climates where the dominant heat load is on the outside from solar gain and high external air temperatures. The advantages of thermal mass and insulation are combined. The lightweight cladding and insulation comprises the external layer, while the thermal mass forms the internal layer and protects from inward heat flux. This means that the thermal mass can stabilize internal temperatures more effectively.

• ***Biodiversity***: the natural pre-existing flora and fauna of an area.

• ***Cross- and stack ventilation***: in moderate warm climates, the purpose of ventilation is to provide fresh air to the occupants, to cool the building fabric and to cool the occupants through air movement and heat loss. Cross-ventilation is horizontal and is usually wind driven; stack ventilation is usually vertically driven by thermal difference.

• ***Soft energy path***: this entails using energy much more efficiently than is common ('doing more with less'), obtaining energy from soft technologies and intelligently using fossil fuels for the transition.

• ***Soft technologies*****:** these are renewable, running on sun, wind, water, and farm and forestry wastes.

• ***Microclimate***: a local zone where the climate differs from the surrounding area.

SUMMARY

A changing context for housing in Brisbane's subtropical climate is occurring through the effects of urbanization on meso-climate conditions. The expansion and densification of the city is changing topographical features: reducing breezes, increasing hard surfaces, eliminating vegetation and elevating exterior temperatures. The changing needs of comfort, the desire for more stabilization of internal temperatures and reductions in humidity have resulted in the use of mechanical systems for climate control, such as air conditioning.

The cultural imperative that this creates is to utilize less *interactive building solution sets* and to create the need for more *defensive solutions* that combine both passive and active systems, using mechanical systems to expel excess heat ather than the natural systems. Chapter 9 and 10 examine some of the solutions that facilitate this defensive approach.

Chapter 6 **Tokyo**: *Warm Temperate Climate*

Traditional **Japanese** houses have a post-and-beam structure, which is similar to the structure of vernacular houses in **tropical zones** such as south-east Asia. There are many air leakages in these houses; the structure is suitable for humid and hot weather. After the oil crisis in the 1970s, the structure was improved to be airtight and insulated using films and other materials. The prefabricated houses with original structures and the imported houses (such as 2 × 4) expanded all over Japan. In these situations, the thermal performance of normal Japanese houses has become higher and the demand level for the indoor climate has also become higher. Especially, the energy consumption for cooling has become higher because of the diffusion of air conditioning and the loss of traditional habits such as opening windows and sprinkling water on the ground before windows. As a result, both of the energy consumption for heating and that for cooling are increasing continuously.

For a better living environment and for energy saving, the solution set considering both winter and summer is very important in Japan. The results of the simulations showed the necessity of the design concept for cooling and heating. This concept can be found in these case studies. The variety of solution sets in the case studies showed that the hybrid of the passive solution methods and the active solution methods is not easy. But the typical solution sets shown above will be a guide to a new design concept and the simulation technologies will adjust the design details.

Chapter 8 **Kuala Lumpur**: *Hot Humid Climate*

Malaysia is situated in a maritime equatorial area, where the climate is generally the same throughout the year, with uniform temperatures, high humidity, light winds and heavy rainfall. Malaysia has a mean minimum temperature of around 22 to 24ºC and a mean maximum temperature of 29 to 32ºC, giving an annual mean of 26.75ºC.

The very nature of the Malaysian climate may necessitate mechanically ventilated or air-conditioned interiors, especially in urban areas. However, poor design and indiscriminate use of air conditioning have resulted in huge increases in energy use. Passive and low energy design strategies are therefore better solutions for a sustainable future.

The comfort band for the Klang Valley area computed using Auliciems's equation for all building types is between 23.6ºC and 28.6ºC, with a neutrality temperature of 26.1ºC (Auliciems, 1981). Since Malaysians, being acclimatized to hot and humid climates, are able to tolerate much higher temperatures, increasing the upper limit of the comfort range would result in greater energy savings.

These climatic consequences make passive design a challenging but feasible option for achieving commercial and residential building comfort standards. Thus, energy efficient design should be directed towards reducing energy demands through natural and fan-assisted ventilation, correct opening schedules, higher set-point temperatures (if air conditioning is being used) proper orientation and siting, reduction of solar gain (that is, shading devices), thermally efficient construction (that is, insulation and use of natural material with low U value), low energy equipment and plant, and improved use of daylight. Finally, trees and gardens that surround houses could also contribute to natural cooling.