Biomimicry: A New Approach to Enhance the Efficiency of Natural Ventilation Systems in Hot Climate

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ABSTRACT: Biomimicry, a new growing area of research in the field of architecture. It offers enormous potentials and concepts that can improve and develop non-biological systems. One of these potentials is enhancing the ventilation systems used in buildings through mimicking the impressive natural adaptation methods found in flora and fauna to hot and arid climate. It is not a simple mimicking of nature; but rather it searches beyond the form towards a better understanding of its adaptation principles. The entire external biological skin of all living organisms is responsible for the adaptation process as well as the thermoregulation system. This concept is not applied in contemporary buildings’ façades. The present research tries to reformulate a new concept called “breathing façades”, firstly mentioned by Hassan Fathy and previously used in traditional buildings, through proposing a conceptual model as a step towards creating buildings that can breathe.

1 Biomimicry: The Science of Mimicking the Nature
1.1 Definition and Historical Background

Biomimicry is the science of copying natural systems and designs, in order to create new industrial products. It is based on what we can learn from the nature, not on what we can extract from it [Benyus, 1998, p.2]. It is defined by J. M. Benyus as the technical term used in biochemistry, biology, pharmaceuticals, engineering, and by material scientists in their quest for properties in living organisms and natural systems that can be extrapolated from observation and scientific analysis, in order to apply them in industry, medicine as well as other disciplines [Benyus, 1998, p.1]. This new science is known by several scientific terms such as; biomimicry, biomimetic, bionic, bio-inspiration, and biogenesis [W. F., 2010a].

Before this approach was scientifically formulated, it was practiced thousand years ago, it was used to increase human capacities and to enhance his daily life tools. In 1956, the term “bionic” was coined by Jack E. Steele, while working at the Aeronautics Division House at Wright-patterson Air Force Base. In September 1960, an American scientific meeting organized in Ohio and used it as a scientific term and defined its objectives as a new discipline [Guillot and Meyer, 2008, p.2]. The term “bionic” is possibly originating from the Greek word “bios” bion, meaning “unit of life” and the suffix “ic” meaning “like”, when gathered it means “like life” [W. F., 2010a], while some dictionaries present the word as being formed from biology + electronics. In 1997, Janine M. Benyus published her book entitled “Biomimicry; innovations inspired by nature”, in which she popularized the term “biomimicry”. The terms Biomimicry or biomimetic are preferred in the technological fields to avoid confusion between it and the medical term “bionics”.

1.2 Biomimicry and Architecture

Copying the natural figures on building façades was the first application of biomimicry in architecture from thousands of years. 2100 years ago, the roman architect Vitruvius opened a new dimension in biomimicry by comparing the propositions of temples with the dimensions of human body. He focused on inspiring propositions from the nature. Eight centuries ago in China, rural populations of Hongcun village are considered the first bionic architects. They designed their village, giving it the form of a caw, while creating a hydrologic network water system in the form of its digestive system [Guillot and Meyer, 2008, p.7-8].

Copying figures, forms and propositions continued till the end of the 18th century as the only application of biomimicry in architecture. The industrial revolution added new dimension in this field which is copying construction systems found in plants and animals, this approach opens the way to a huge number of new construction designs. The Lily house in Strasbour and the crystal palace in London designed by Joseph Paxton are examples for such inspired constructions [Guillot and Meyer, 2008, p.14]. In the middle of the 20 century, Robert Le Ricolaïs, a French professor at the University of Pennsylvania, developed new structural models through copying biological structure models drawn by Germane biologist called Haeckel during the 19th century [Guillot and Meyer, 2008, p.15].
During the same period, many architects and engineers, such as Frei Otto, Frank Lloyd Wright and others, designed their buildings by copying to natural forms, structure and proportions creating impressive new designs such as Munch Olympic stadium, Guggenheim museum in New York, S.C. Johnson & Son Inc. administration building with its mushroom columns, and The price tower which imitates the structure of the tree, etc.

**Figure 1:** (a) Amy Paxton demonstrating the strength of a sheet of water lily Victoria amazonica which was the design source of (b) the Lily house in Strasbourg, (c)ROPert Le Ricolais with his structure designs [Guillot and Meyer, 2008, p.14,15].

At the end of the 20 century, as being the era of modern and advanced technologies; nanotechnology, artificial intelligence, information and telecommunication, it is now the time to add new values to biomimicry. The new added value was to imitate natural systems and process, and to look beyond the form and structure, and discover how the natural organisms work in order to create new building systems.

### 1.3 Why Biomimicry Now?

Beside the positive aspects of the industrial revolution, it had negative impacts on our environment. It is not new to say that the current way to deal with the environment and the way we consume energy, is a catastrophic way. Architecture is one of the fields that are reasonable for this result. On the other hand, we find that natural organisms interact with the environment for millions of years in a successful and sustainable way, without vanishing natural resources or polluting the environment. They designed highly efficient biological systems that can adapt themselves to the surrounded environmental conditions in order to overcome challenges.

Simultaneously, the availability of biological information which is duplicated every few years now, give us new opportunities day after day to discover new ideas, designs and systems. Also, it gives us the ability to transform them to architectural concepts. Previous reasons support our beliefs that the biomimicry is one of the approaches which will guide the technological development in the field of sustainability. This approach will encourage us to go beyond simply sustaining current conditions, and to work as an environmental restorative approach, in other word, to work as a part of natural ecosystems.

The current research tries to benefit from the availability of information in order to imitate the successful effective biological systems, it takes the biomimicry approach as a design process, not as copier of forms, structure or proportions, but by imitating natural systems as a step to create restorative elements.

### 1.4 Objectives and Scope of Work

Biomimicry as a design process is divided scientifically into two groups [Pedersen Zari, 2007, p.2]. The first group deals with discovering new particular biological behavior, function or characteristics, then applying them to create new designs “biology influencing design”. This approach demands sophisticated scientific analysis of biological systems, so it needs a cooperative scientific team with the designer. While the second approach deals with creating new designs by looking to natural organisms and ecosystems in order to study how they overcame the same problems that designers faced in their designs “designs looking to biology”, this approach does not need the same deepness of scientific analysis.

Within these two approaches designs could mimic three possible dimensions; physical component (form, structure, material), functional task (process) or ecosystem. Most of the existing
examples are related to the first dimension; form, structure and material. Designs that mimic functional tasks are less in number. Zimbabwe’s Eastgate center, opened in 1996, is one of the most famous architectural examples of this category. Mick Pearce, the designer, tried to provide thermal comfort for his building by mimicking the ventilation system used in termite towers found in local nature [Turner and Soar, 2008, p.1]. While it is very difficult till now to find designs of the third category “ecosystem”. One of them is Lavasa project copying the same proportion as the original ecosystem found in nature [Baumeister, 2008, p.2].

Current work follows the second approach which is mimicking the nature by looking to its systems and process in order to learn how natural systems can overcome the same design problem. One of the most important design challenges in architecture is designing ecological cooling systems in buildings located in hot regions as in Sinai, Egypt. In fact, Cooling and heating purposes is consuming the highest amount between building sections. In hot climate, this is due to using mechanical air-conditions, and ignoring the natural ventilation in our modern buildings [Elghawaby, 2006, p.273].

Simultaneously, the nature offers numerous examples and solutions of adaptation to hot climate. These natural biological systems do not only offer special physical characteristics but also functional systems. This research tries to imitate such biological systems of adaptation found in flora and fauna living in Sinai in order to transform them into architectural ventilation and cooling systems.

2 Sinai: Climatic Challenges and Biological Solutions

Sinai is a triangle shaped-peninsula situated between the continents of Asia and Africa, it has a surface area of about 61,000 km$^2$, surrounded by the Mediterranean sea from the north, the Suez Canal from the west, the Red sea from the south-east and south-west, and the Palestinian-Israelian frontier from the east.

2.1 Climatic Challenges

Sinai enjoys typical desert climate; hot and arid, but it could be divided climatically into four main micro-zones as shown in figure 3. The first zone is the northern coast; it consists of flat sand dunes with Mediterranean climate. The second zone is the central desert located in the heart of Sinai with hot and dry climate. The third section is the southern rocky high mountains which contain the highest mountain in Egypt (Saint Catherin Mountain, 2,637 m). The climate of this zone has significant differences in temperature between day and night, summer and winter, due to the presence of high mountains. The forth zone is the southern coasts which has a hot and semi-arid climate [Siliotti, 2000, p.6-7].

![Figure 3: Sinai and its climatic zones](Researcher)

The desert is the predominating element in Sinai, covering almost the entire surface of the peninsula. Deserts are characterized by environmental stresses of low relative humidity, irregularity and unpredictability of precipitation, and high temperature, especially during daytime and summer months. More frequently, long periods with a mean maximum above 40 °C are recorded [Costa, 1995, p.13]. These harsh environmental characteristics create difficult conditions for living organisms; plants, animals and human. In spite of these harsh climatic conditions, numerous and different means of adaptation methods to hot and arid climate are developed and used by most of living desert organisms. Most of them develop different means and systems response to two main factors: high and fluctuating temperature and extremely low water availability.

1 At Lavasa project, they found that estimated 20-30% of the rainfall is returned to the atmosphere directly, 10-20% ends up as surface runoff, 40-60% is absorbed in the vegetation and soil, and 7-10% is channeled through underground pipes in the steep forest terrain. So, they tried to design the project with its landscape to match these proportions.
2.2 Adaptation of Fauna to Hot and Arid Climate

Sinai has a good number of land fauna, consisting mostly of foxes, gazelles, ibexes, camels, small rodents, and some genera of reptiles [Siliotti, 2000, p.8-9] [Zalat, 2008, p. 115-162]. In general, desert animals have the ability to alter their internal environment and posses a numerous of possible adaptive strategies responding to hot climate. These strategies vary between behavioral, morphological and physiological adaptation strategies. They aim at avoiding heat gain, losing internal overheating temperature, protecting their bodies by good insulation by several means such as the following examples:

a) Cooling systems
   - The sweat glands of many mammals aid thermoregulation through evaporative cooling [BI, 2008a].
   - In case of body overheating, the air scoops on the sides of ants cool them through evaporative cooling process [BI, 2008d].
   - Gular or tongue fluttering cooling method; Some birds, frogmouths, nightjars, and potoos can avoid hyperthermia by using evaporative cooling strategies, through opening their mouths while increasing the rate of blood flow to the buccal area, and vibrating rapidly the moist gular area [BI, 2008e].

b) Dissipate internal heat
   - Several animals such as foxes, jackrabbits and mule deer have evolved large appendages (ears) to function as efficient heat radiators [Costa, 1995, P50] [BI, 2008c].
   - In hot conditions, the hair on the skin lays flat, preventing heat from being trapped by the layer of still air between the hairs. These flat hairs increase the flow of air next to the skin increasing heat loss by convection [P. W., 2008].
   - The blood vessels of vertebrates regulate temperature by allowing more blood flow to the skin when cooling is needed and restricting blood flow to the skin when heat must be conserved [BI, 2008f].
   - Animals that can't sweat efficiently pant; this is because the lungs have a large surface area. Air is inhaled, cooling the surface of the lungs and is then exhaled losing heat and some water vapor [Costa, 1995, P50] [W. F., 2010b].

c) Insulation skins
   - Some animals have thick coat with dense hair, it does not only protect animals from cold winter, but it insulates them from summer heat [Shenbrot et al, 1999, P.89] [Costa, 1995, P49].
   - Coloration is an important factor in reducing of heat absorption, so lighter colored coat is more familiar in desert animals [Earlham Collage, 2006].

d) Avoiding heat gain
   - Most rodents are nocturnal, sleeping in a cool cave or burrow by day and emerging at night, or they are active for few hours during the daytime.
   - Moving rapidly or rise up its body over the heated sand like snacks and most reptiles [Earlham Collage, 2006].

e) Retaining water
   - Different animals adopt different mechanisms to produce enough water such as sand lizard. It has hygroscopic skin to absorb moisture from the air.
   - Some animals retaining water by burrowing into moisture soil during dry daylight hours [Dessert USA, 2004].

f) Decreasing water loss
   - Desert animals prevent water loss from their body by reducing surface area exposed to direct sunlight, and by reducing the number of sweat glands [Dessert USA, 2004].
   - Camels can store water in the tissues all over the body, and use it economically. They can also conserve water by removing it from air during exhalation [Yagil, 1985, P.13].

Figure 4: (a) Fox's ears and hairy coat, (b) Coloration, thick coat and moving rapidly, (c) Resting in burrows, are examples of natural thermal adaptation to hot and arid climate [Siliotti, 2000, p.8-9].
2.3 Adaptation of Flora to Hot and Arid Climate

In Sinai, the flora consists mostly of acacia, willow, olive, figs trees, palms and small shrubs such as the green Capparis, Artemisia judaica mugwort, mint, etc [Siliotti, 2000, p.12-13, 18] [Zalat, 2008, p.57-113] [Springuel, 2006, p.64-138]. It might seem strange that plants and shrubs should grow in such harsh conditions, but their adaptive capacity is truly amazing. The difficult living conditions in this barren land have triggered a series of transformations in the structure organs of the plants and shrubs, adding new functions to stay alive, following numerous adaptive methods such as:

a) Cooling systems
- Plants loss heat through the process of the transpiration, in which the plant carries water from the soil around its root to the leaves, then evaporates water through specialized openings called stomates [Gibson, 1996, p.30] [Batanouny, 2001, P.116].

b) Insulation skins
- Thick external layers and waxy covering, which reduce heatgain [Earlham Collage, 2006].
- Leaves cells that can absorb moisture and store it, creating an insulation layer [Batanouny, 2001, P.116].

c) Avoiding heat gain
- Dense small leaves, spines and hairs instead of large leaves to decrease surface exposed to direct sunlight and insulate the plants against heat gain, while allowing the fresh air to pass between them [Gibson, 1996, p.26-29] [Springuel, 2006, p.23] [Batanouny, 2001, P.119].
- Rotating leaves which enable the plant to orient its leave away from maximum exposure to the sun [Batanouny, 2001, P.115].
- Leaves of Mangroves minimize heat gain, enhancing cooling, minimizing water loss, and maximize photosynthesis by optimizing tilt angles and leaf size [BI, 2008b].
- Cacti stay cool by having ribs that provide shade and enhance heat radiation [BI, 2008b].

d) Retaining water
- Long vertical roots (up to 25 m deep) enabling a plant to reach underground water sources.
- Shallow, radial roots, those which extended horizontally, which maximize water absorption at the surface [Springuel, 2006, p.19].
- Water can be stored in roots, stems and leaves.

e) Decreasing water loss
- Recessed and reduced stomates which decrease water loss. Many plants open their stomates only at night [Stoller eser, 2001].

3 What Can Biomimicry Offer to Enhance Building's Cooling and Ventilation Systems?

In the previous part, many biological examples of adaptation to hot and arid climate are presented. They are based on different methods to overcome the climatic challenges of high temperature and water scarcity. These methods aim at avoiding direct sunlight, dissipating overheating or providing the exterior skin with good thermal insulation. These methods work as a part of a thermoregulation process to control the internal body temperature. These adaptation concepts could be considered as conceptual basis for a range of architectural solutions suitable to the climate of Sinai.

3.1 Cooling Concepts Inspired by Nature

Adaptation methods concern physical characteristics, behavioral reactions or cooling processes. Physical characteristics help in reducing heat gain through using small surfaces exposed to sunlight, high density, high proportion of internal volume to surface size, and fade colors. Other physical characteristics are to increase thermal insulation such as the presence of spins, hair, waxy and thick external layers.
Beside these physical considerations, impressive behavioral reactions are been taken by plants and animals. Some plants, such as Mangroves found in south Sinai, avoid direct sunlight by rotating their leaves away from sunlight, while some animals, such as lizards, rest in burrows and shaded areas or move rapidly or rise up their bodies away from heated ground. The same attitude was mimicked or could be imitated in buildings as active systems. Buildings could rotate, use movable shading devices, windows and controlled wind catch. It could be also transformed into constant features like constructing underground buildings or raise them above the heated ground with high columns.

The third group of adaptation methods is cooling systems and processes, in which the present paper is interested. These methods depend generally on earth deepness, water or natural ventilation to release the internal heat by convention or conduction. Using the earth deepness in cooling was found especially with animals. In architectural field, some passive cooling systems such as the underground air flow tunnels are created by mimicking this concept.

In case of water availability plants, animals as well as human reduce temperature by evaporative cooling through transpiration and sweating processes [Costa, 1995, P50] [Batanouny, 2001, P.116]. Some animals induce evaporation by vibrating rapidly specific wet organs, while some animals and human induce sweating by increasing blood flow to their skins [Wigginton, 2002, p.28]. Although the scarcity of potable water resources in Sinai as an arid desert, buildings could use sea water, which is available everywhere and could be desalinated and reused. Buildings can also extend artificial roots in searching for underground water.

Natural ventilation is also considered as an important cooling resource. Some animals open their mouths and pant rapidly to use their lungs in releasing the internal heat. Others use large appendages like ears to act as heat radiators. While third group of animals increase blood flow to their skins. Some similarities could be found between biological cooling systems and architectural ones like in wind catches and fox’s large ears, but the main difference is that animals use natural ventilation for cooling their lungs, ears and skins, while buildings gain heat from its external walls. Buildings allow air flow to pass by certain points; windows, doors, and sometimes wind catches or mechanical systems.

3.2 Similar Concepts and Different Results

Generally, one can easily observe the similarity of cooling concepts between biological and architectural systems. Similarity is very clear between the function of fox’s ears and wind catches, burrows and underground cooling tunnels (thermal labyrinth), sweating process and evaporative cooling by sprayed water system, rotating leaves and rotating buildings or shading devices, nocturnal animals and night cooling, etc. these observations approve that architecture is trying hardly to imitate natural systems, but it also raises questions about why architectural cooling and ventilation systems did not achieve the same impressive results as biological ones, from the ecological point of view?

One of the weakest points in mimicking thermal systems is that natural skins function as an adaptive layer between internal spaces and external ones while being well connected to a central thermal process called thermoregulation process. On the contrary, building façades work as an insulating layer. In biological systems, the entire surface of natural skin plays an important role in cooling interior organs by direct contact with air flow or by evaporative cooling through transpiration or sweating processes. This concept transforms skins into a thermal adaptive layer between spaces thus as cooling elements in hot climate. While designing building façades as insulating partitions lead to create deaf walls, causing more or less heat gain from the exterior spaces. Façades should have the ability to work as a thermal adaptive layer, in other word, can use water, earth deepness and natural ventilation to cool buildings. Adding this function to façades will transform them to work as cooling elements and will certainly lead to improve thermal comfort conditions in buildings.

4 Skins Instead of Façades

The idea of adding specific properties of natural skins to building façades is mentioned and applied before by several recent approaches, but they mainly focus on self repairing, autonomic responses and multi-function tasks. The notion of building’s skin was defined by Michael Wigginton and Jude Harris in their book “intelligent skins” as “the notion that the fabric of the building may not be inert, but may itself change dynamically, in order to maintain comfort with the least use of energy” [Wigginton, 2002, p.23].

In the next section, the research tries to identify the needed features to be added to building façades in order to convert them into dynamic interactive thermal skins in order to be capable of controlling natural ventilation to work as cooling systems. This approach requires firstly a deep understanding of the anatomy of natural skins, and its thermal adaptation principles to hot climate, as a step to apply these principles in façades.
4.1 Biological Skins as a Thermal Adaptive Layer

The human skin consists of two distinct layers; the 'epidermis', which forms an outer layer, and the inner layer known as the 'dermis'. The epidermis contains pigments, pores, and ducts, and is only a few cells thick. Whereas the inner layer 'dermis' consists of a network of protein, blood vessels, nerve endings, fat tissues, bases of hair follicles and sweat glands. One of the skin's roles is regulating the body temperature; this action is occurred through sweating process. If the body temperature is overheated, the thermal sensors send alerts to the brain which order the sweat glands to be activated. The sweat glands can cool the body by secreting moisture, which evaporates, and cool the body surface. Also the blood vessels in the dermis can supplement temperature regulation by contracting to reduce blood flow, and thus reduce radiant heat loss through the skin [Wigginton, 2002, p.28-29].

In order to act as a thermal adaptive layer natural skins have some specific principles which are:

- Multi-functions layer includes the ability to reduce the body temperature through evaporative cooling process and direct contact with external air flow, beside its function as an insulation layer.
- The entire surface of external skin is participating in reducing body temperature though sweating process.
- Elements that are participating in the cooling process should be coordinated and connected with thermal sensors to collect needed information and the brain to analyze it and give decisions.

**Figure 6: Human skin consists of two main layers which are 'epidermis' and 'dermis' [Wigginton, 2002, p.28]**

To convert façade to skin, the mentioned principles should be added and applied in building façades. These principles aim at adding a new task to building façades which is working as a thermal adaptive layer through the ability to benefit from natural ventilation with the entire surface of external walls. Applying this concept means turning the entire façades to wind catches, in other words, converting insulation partitions into skin that can insulate and breathe in same time.

Have we ever thought, what can be changed in building’s thermal behavior if the overall area of the façades has the ability to deal with natural ventilation, in other words, having “breathing walls”?

4.2 Walls That Can Breathe

The notion of “breathing/breathable walls” is used in the field of Baubiologie which was coined in Germany in 1969, but the term itself is used in an imprecise manner. There is considerable confusion about what constitutes a "breathing" wall. Although "breathing" implies airflow, in most of scientific literature, the term 'breathing walls' simply means that wall that is capable of diffusing water vapor to assure the indoor air quality (IAQ) [Straube and Acahrya, 2002].

From another point of view, Hassan Fathy used the same term to describe the ability of allowing airflow to pass through walls made of natural materials, in addition to its capability to absorb the moisture from the air, thereby, reducing the air temperature by evaporative cooling. The current research shares the same definition introduced by Hassan Fathy, describing the walls element that allowing slow and controlled airflow to pass through it [Fathy, 1986, p. 8].

Following the same definition, the Bedouins, who are the original inhabitants of Sinai, have their own adaptation solutions to hot climate which appeared in their traditional cloths as well as their tents (fig. 7). Traditional black and heavy cloths have the ability to breathe. Although they do not seem suitable for hot climate, they work with the same logic, through absorbing the moisture, allowing air flow to pass by the entire surface then cooling human body by evaporative cooling.

Traditional tents made of animals skins and natural materials, used by the Bedouins of Sinai, are also considered breathing building. They have the ability to absorb moisture from the air and allow the passage of airflow through the entire surface, thereby reducing the temperature by evaporative cooling, with guarding its ability to prevent direct sunlight.
On the contrary, this concept has been completely neglected in recent and modern façades in hot climate, leaving the task of ventilation to windows, causing high amount of energy consumption for cooling systems.

As mentioned before, the concept of creating adaptive layer that can breathe is applied in biological skins (plants, animals and human), Bedouin’s tents and traditional cloths. This could be considered as an evidence of the importance of applying the same concept in recent façades in order to enhance ventilation systems towards decreasing energy needed for cooling process.

4.3 Breathing Wall Model; New Building’s Skin Adapted to Hot Climate

Current research proposes a conceptual model of “breathing wall” capable of controlling air flow through the entire surface, while cooling it. This model works as an adaptive layer suitable for buildings located in hot climate such as in Sinai. It consists of three layers which aim at minimizing direct sunlight, allowing airflow to pass and thus cooling it. Each layer has specific features and tasks;

- **External layer** is capable of preventing or minimizing direct sunlight. It can be simple layer made of material that has the ability to absorb the moisture such as natural textile, clay, wood or reeds. This layer can be more sophisticated layer consisting of openable slots capable of controlling the intensity of sunlight according to a preprogrammed needed orders or according to the occupancy desire.

- **Middle layer** resembles the “epidermis” layer in human skin, it contains controlled airflow entrances, water sprayed system and airflow duct network. This layer aims at achieving three tasks; thermal insulation, cooling airflow by evaporative cooling then receiving and controlling airflow by duct network. Controlled airflow can be re-cooled by convection with earth deepness or other natural resources like underground water or sea water.

- **Internal layer** contains controlled ventilation outlets managed by both building management system and occupancy desire. This phase could contain a condensation process for obtaining potable water. This process can mimic camel’s nose which is capable of extract water vapor from exhaust air.

This paper suggests that this concept could be applied with traditional simple elements or with advanced technologies; such as nanotechnology, artificial intelligence and telecommunications systems. These sciences help building façades to breathe in order to cool the interior spaces, which mean converting the entire façades to work as thermal adaptive layers.
5 Conclusion

Nature has been evolved for billions of years. It has developed systems that are highly effective and suitable for the intended tasks. Mimicking the nature has been practiced for a long time ago creating a huge number of inventions in all fields. Recently, this approach was scientifically formulated and organized under the term ‘biomimicry’. Architecture was one of these fields trying to copy the nature to enhance and improve its capabilities. It starts with imitating figures, propositions, forms and structure. It was not until the end of the 20th century it became possible to imitate natural processes and ecosystems in our buildings. This approach helps us in discovering new techniques and concepts that can enhance our building systems.

One of the impressive biological processes is the ability of climatic adaptation found in natural organisms. Flora and fauna offer numerous examples of adaptation methods to hot climate by means of physical characteristics, behavioral reactions or cooling processes. Beside these concepts, natural skin plays an important role, as a thermal adaptive layer, in regulating body temperature of living organisms. When applying this concept into building façades in hot climate, it means that façades should have the ability to deal with climate, especially natural ventilation in order to act as an adaptive layer capable of cooling interior spaces. This approach introduces the concept of ‘breathing walls’ to be used in buildings in hot climate, transforming it into an adaptive wall capable of controlling the movement of airflow through its entire surface.

A conceptual biomimetic model of ‘breathing wall’ has been developed by current research as a new way to control natural ventilation by building’s skins. This new approach can help in enhancing cooling and ventilation systems and achieving thermal comfort in buildings located in hot climate such as in Sinai. Applying such concept will transform them into controlled wind catches. Also, by this approach the notion of envelope will be changed to skin, in other words, walls will be able to breathe and in the near future buildings will be almost alive.

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