Abstract
Architecture is the art and science of designing which involves the manipulation of mass, space, volume, texture, light, shadow, materials, program and other elements in order to achieve an end which is aesthetic, functional and sustainable. Sustainability is a growing trend within the field of architecture, it is currently the most pressing, complex and challenging agenda facing architects. The industrialization and modernization of the world has led to increased initiatives regarding sustainability debate, where recently the word ‘sustainable’ entered into the consciousness of architects and became an essential concern in the discourse of architecture. What is more, we are nowadays witnessing the defense of former ways of life that affect not only the architecture, but also the habitat, work, and, in short, what can be called sustainability. Although sustainability at the human settlement scale has received great attention so far in most of the developing countries, it still remains the most glaring challenge in terms of its demand on resources and expertise.

The aim today is to bring modern technologies and knowledge representing design solutions as guidelines like double skin façade, adapting traditional concepts, in tune with such practices to develop solutions that provide us with sustainable buildings that interact and are in harmony with natural climatic conditions. The paper will make an attempt at highlighting sustainability challenges we currently face including its implications for the built environment, in order to propose a sustainability evaluation framework, drawing out transferable lessons learned for future development.

Keywords
Sustainability; transparency; façades; double skin; traditional design

Introduction
Cities are artifacts of information, technological change, economic growth and cultural transformation. In that sequence, the developed world is built by rearranging the relationships between houses, cities, green areas and human beings according to their requirements. Man has the right to live in a beautiful world and he has the responsibility to contribute to the make-up of his environment. Despite social and scientific advancements, setbacks are common in the development of cities. Some of the reasons can be traced to misplaced priorities and short sightedness, with regard to global interaction of both natural and engineered systems. Thistrend of accounting for development is variously referred
Sustainable Architectural Design: Reviving Traditional Design and Adapting Modern Solutions

Sustainable development (Alshuwaikhat & Nkwenti, 2002). Achieving sustainable cities is a challenging, and at the same time, a daunting task. Throughout history cities have been very complex products of human activity. Now there is a growing worldwide attention to sustainable development, where the needs of today’s generation do not conflict with the abilities of future generations to fulfill their needs. The term has been propelled in an attempt to find a balance between the human economic, social and environmental activities, as well as satisfying the needs of the present generation without compromising the chances for future generations (Hall, 1998).

The construction industry and its activities are responsible for a substantial amount of climate change and waste emissions. It also has an important role to play in socio-economic development and quality of life. The need was subsequently identified for an internationally agreed upon agenda for sustainable construction to guide the industry in preparing for and implementing the principles of sustainability and support Agenda 21 and the Habitat Agenda. The desire to control the indoor environment to the occupant’s best wishes resulted in the implementation of mechanical climate control systems. Buildings themselves became completely separated from the (outdoor) environment they were placed in. As Maver (qtd in Looman, 2007) puts it, “one of the most (missing word?!) market trends in architecture over the centuries has been that of replacing the functions of the building structure by engineering service systems”. As residents increasingly voice their demands for better quality living environments via local Agenda 21 initiatives, and as governments advocate quality and sustainability in design, many experimental urban or rural housing and neighborhood planning and designing projects have been encouraged worldwide to promote sustainable settlement development, development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

**Sustainability**

Sustainability is the concern of the best thinkers of our age; it can be traced as an underlying theme in the Harry Potter books, in Seamus Heaney’s reinterpretation of Beowulf, and in Peter Hall’s rewriting of urban history. It is meeting the needs of today considered the necessity of preserving the earth for future generations to create a sustainable planet to bond civilization (James, 2005).

For many of the world’s best architects (i.e., Piano, Yeang, and Foster), it is the challenge of our age; the first unifying basis for a new architecture since Le Corbusier, “Towards A New Architecture” was published in 1927 (Edwards, 2001). Sustainability is currently the most pressing, complex and challenging agenda facing architects. The ever-expanding urban population of the globe has meant that over the last decade it has moved on from being a single concern, focused largely on global warming, to one where much wider issues of the environment and health are at stake.

One of the most often-cited definitions of sustainability is the one created by the Brundtland Commission, led by the former Norwegian Prime Minister Gra Harlem Brundtland. The Commission defined sustainable development as “development that meets the needs of the present without compromising the ability of future generation to meet their own needs”. The definition...
was carried further by Berke and Manta which reads, “sustainable development is a dynamic process in which communities anticipate and accommodate the needs of current and future generations in ways that reproduce and balance local, social, economic, and ecological systems, and link local actions to global concerns” (qtd in Alshuwaikhat & Nkwenti, 2002). More specifically, sustainability can be defined as simultaneously enhancing economic growth (economy), social progress (equity), and environmental protection (ecology & institutional) issues. In this definition the combination of social progress and environmental protection stand for meeting future needs. The economic considerations (economy) relate to questions about the financing of the infrastructures, maintenance and utilities required for the built environment to accommodate the urban development process and employment of resources associated with this. The social issues (equity) concern matters about access to such services, the safety and security of cities, human health and well-being cultural heritage provides. The environmental issues (ecology) take on the form of considerations about how the process of urbanization consumes natural resources, energy efficiency, and the effect development has on the biodiversity of habitats. The institutional issues refer to the governance, justice and ethics of settlement patterns subject to urban development (Ree & Meel, 2007).

**Energy and Design Control**

A starting point for buildings to become minimal energy consumers is by minimizing their energy-demand. High performance architecture meets both comfort and energy issues to a maximum level. On the other hand, it is good to realize that low-energy design of buildings, where no attention is paid to comfort and health can as well become non-sustainable due to higher energy use of occupants to compensate for the discomfort. Building systems are sometimes designed from the single objective of providing optimal comfort while energy-efficiency was not considered at all. It seems that at a time when consuming energy did not ring a bell on resource depletion and environmental damage, comfort became a synonym with high energy consumption.

We often underestimate the tremendous influence of the introduction of mechanical air-conditioning systems on the evolution of architecture. Such systems have severed the relationship between the building and its natural climatic environment. Accordingly, both designers and clients have become less concerned about how their buildings relate to factors such as the movement of the sun, direction of the wind and changes in outside temperatures. Mechanical systems, control of climatic conditions within a building and, therefore, a decision as to whether or not to sheath a building with a curtain-wall glass façade, for example is unfortunately now most often based on factors unconnected with climatic issues. Obviously, such an approach is neither sustainable nor responsible. The use of mechanical air-conditioning and cooling systems further contributes to carbon-dioxide gas emissions in the environment, thus increasing problems relating to pollution and global warming. It is also economically inefficient and wasteful (Figure 1).

Energy goals in design is to use passive solar energy through orientation and using of renewable energy source like solar, wind, etc. Also, energy goals in design are to emphasize the use of natural light, ventilation and energy conservation to control heat loss and gain.
Traditional Design

In pre-modern times, people had no choice but to live in harmony with nature. Natural forces were too powerful for available technologies to tame or keep at bay. In this context, the traditional design of the Islamic world, which extends over a wide geographical area with various climatic conditions, such as the moderate, hot and humid, the moderate tropical, and the predominant hot-dry climates, has always been able to effectively respond to its natural environment (Edwards, 2001). The energy efficiency of buildings greatly and easily increased at little cost, and in a manner that does not negatively affect lifestyles. Moreover, achieving such efficiency does not necessitate the use of technologically complex, untried and experimental gadgets, but can be realized through incorporating a number of traditional pre-modern cooling systems that are very much in tune with nature.

A second track in achieving energy-efficient, climatically interactive design involves the use of appropriate materials for buildings, including walls and roofs. For example, the use of high thermal-capacity materials for walls and roofs provides thermal masses that regulate the temperature within structures located in hot-dry zones. The mud and straw, adobe or stone walls of traditional buildings of Islamic regions have served as thermal masses by limiting the penetration of heat from
the sun during the daytime, and returning this heat to the outside during the night. Thus, dealing effectively with the city’s harsh summers, shutters provide a simple solution, since they need arises to regulate the entry of the sun. Traditionally Mashrabiyyas, grilled wooden window screens, have been used to control the entry of the sun, and there are many examples of them around the Islamic world (Gabber, 2009). It is worth mentioning here that in traditional architecture, careful attention is paid to the location and size of windows in order to regulate the circulation of air through buildings and the entry of sun. This is evident in the placement of openings in the walls bordering courtyards, in allowing for cross ventilation and in the use of high-level windows to let the hot air out. Also, Shukhshikhas (clerestory windows) were commonly used as wind and breeze regulators, as in many of Cairo’s traditional houses.

Building form and plan layout contribute to the creation of climatically sensitive buildings. The arrangement of building components around courtyards is a common plan layout of traditional buildings in Islamic regions, and the role of courtyards as temperature regulators has been extensively dealt with. Urban fabrics affect the degree to which buildings may achieve energy efficiency. Obviously, the more it is possible to physically connect buildings, the better those buildings are able to function together as one unit in terms of climate control. Under such circumstances, each building would provide the adjacent building with additional protection from the elements (Mortada, 2003). For example, the compact urban of old Islamic cities in hot-dry regions, such as Cairo, where there are often no setbacks from one plot to the other, and no exposed façades except for those facing adjacent streets, is a good example of buildings functioning together as elements of climate control. On a related note, narrow streets often found in such traditional cities also provide sensitive climatic solutions since they limit the penetration of the hot summer sun into the space of the street, and allow the street to remain in shade during much of the day. However, urban arrangements in modern cities in the Islamic world, with their dispersed buildings (often glazed high-rises) and wide streets, are climatically inappropriate. The cumulative effect of these changes is so far-reaching as to make poverty itself a major global scourge (Wheeler & Beatley, 2009).

**Climate-Responsive Buildings**

Sustainability and “green architecture” have become important architectural issues today as concerns about depletion of natural resources, reuse of natural and synthetic materials, as well as conservation of nonrenewable energy resources take on global proportions (Ali & Armstrong, 1995). For optimal performance on both comfort and energy issues, a potential design solution is an integrated building concept where climate-responsive building elements are combined with energy strategies, and sustainable building systems for climate control. A responsive building is a building that is able to adapt or react to changes in the environmental conditions. Building elements that specifically address this feature are called climate-responsive building elements. In this context climate-responsive refers to internal and external climatic conditions and to occupant intervention. Therefore, climate-responsive building elements actively store and transport heat, light, air and moisture. They form an integrated part of the building structure (e.g. roof, wall, and floor).
For optimal performance on both comfort and energy issues, a potential design solution is an integrated building concept where climate responsive building elements are combined with passive energy strategies, and sustainable building systems for climate control as shown in Figure 2.

By responding to changes in dynamic conditions, climate-responsive building elements contribute to maintaining a comfortable environment with an improved energy performance. The use of climate-responsive building elements more or less reverts to the original combined role of a building structure to meet both the function it was created for and to provide comfort, where extreme climate has incurred a heavy reliance on air conditioning.

Figure 2: The stages for producing integrated building concept representing the relation between the inputs, systems (building services) and the required output (Source: Author).

**External Facades**

External facades are one of the most significant elements in the design of any building. Whether there are relatively small punched openings in the facade or a completely glazed curtain wall, windows are usually a dominant feature of the building’s exterior appearance. They are among the most important components in building construction. They provide social identities and environmental comfort for accommodation. It is an intermediate location where collective and individual needs meet. It is related to the environmental performance of the building, the cost and technology provided, and the relationship between the territories between inside and outside. Finally, it is still the major component of the building form which imposes a large impact to the larger environment if not limited in visual. Building energy consumption is directly related to its orientation and to the buildings materials selected, where orientation of building means placing on site in such a way that it gets the maximum advantages of natural sources for maximum possible functional comfort. Building façade is one of the most complicated issues in building construction and management. Traditionally architectural design treated as an outlook, which may reflect the design styles of the time and interests of the clients or designers, beyond the basic functional needs, such as natural lighting and ventilation. Because of recent developments in technology, especially those related to the glass and curtain wall construction and the sustainable issues involving energy saving, more research efforts emerge (Beisi, 2007). Because natural light is seen as a key driver to people’s well-being, both in the workplace and at home, a maximum glazing naturally became the solution. Fig.3

Many architects and their clients prefer buildings with all-glass facades. In most cases, such buildings use a single-skin façade consisting of fixed glazing.
(windows) that forms the outer surface of the building. Relative to buildings with largely opaque facades, they tend to have higher space conditioning loads from heat transfer through the building envelope because windows pose less resistance to heat transfer than insulated walls. Recently, building designers have begun to use double-skin facades (DSF) to attempt to improve the thermal energy performance of facades of buildings with high glazing fractions (Roth, 2007). Sustainability is iteratively changing based on evolving knowledge that connects science and design. Double skin façade is getting more and more attention as it provides many possibilities for creating good door environment (Williams, et al, 2007), it is considered an example of climate-responsive architecture towards sustainability, a system consisting of two glass skins placed in such a way that air flows in the intermediate cavity. The ventilation of the cavity can be natural, fan supported or mechanical. Apart from the type of ventilation inside the cavity, the origin and destination of the air can differ depending mostly on climatic conditions, the use, the location, the occupational hours of the building and HVAC strategy. The glass skins can be single or double glazing units with a distance from 20 cm up to 2 meters. Often, for protection and heat extraction reasons during the cooling period, solar shading devices are placed inside the cavity Figure 4. Simply put, a shading device within the double skin can absorb solar gain and re-radiate it as heat trapped in the cavity. Apertures at the wall’s top and bottom induce air movement. The heat’s natural tendency to rise pulls fresh, cool air in at the bottom while exhausting hot air out the top. Controlling the capture or venting of this trapped heat dictates cavity air temperature and, in turn, the inner glass surface temperature (Husain, et al, 2009).

Uuttu (qtd in Poirazis, 2004) described the double skin façade as “a pair of glass skins separated by an air corridor”; the cavity is connected with the outside air so that the windows of the interior façade can be opened, even in the case of tall buildings subject to wind pressures. This enables natural ventilation and night time cooling of
the building’s thermal mass. In winter the cavity forms a thermal buffer zone which reduces heat losses and enables passive thermal gain from solar radiation (Figure 4). All types of double skin facades offer a protected place within the air gap to mount shading and daylight enhancing devices such as venetian blinds and louvers. Sheltered from wind and rain, these shading devices are less expensive than systems mounted on the exterior (Poirazis, 2004).

As indicated by the term “double-skin” such a facade is intended to mean a system in which two “skins” - two layers of glass - are separated by a significant amount of airspace, that is to say, a second glass facade is placed in front of the first. These two sheets of glass act as an insulation between the outside and inside enabling the air to circulate between the cavity of the two facades skin providing good air circulation, thermal and acoustic performance, etc. The type of double-skin facade then determines the type of air circulation. Of course, the most interesting systems are those designed in such a way that in addition to permitting natural air circulation, they also use solar energy, converting it into electrical energy.

Hendriksen, Sorensen, Svensson and Aaqvist (qtd in Poirazis, 2004) support that the transparency is often seen as the main architectural reason for a double skin facade, because it creates close contact to the surroundings. This, in fact, is also derived from a client’s point of view saying that physical transparency of a company gives a signal of a transparent organization with a large degree of openness. In almost all the literature sources, transparency in architectural design is mentioned as the desire of the architects to use bigger portions of glazing surfaces. As Lee et al. (qtd in Poirazis, 2004) claim, “the double skin facade is a European Union architectural phenomenon

Figure 4: Double skin concept as a climate responsive architecture element (ventilation cavity) including shading devices (Source: Poirazis, 2004).
driven by the aesthetic desire for an all-glass façade”. According to Kragh (qtd in Poirazis, 2004), transparency in architecture has always been desirable and the problem has always been to realize a transparent building envelope without compromising energy performance and indoor climate. For years, the development of advanced façade and environmental systems has aimed at creating fully glazed buildings with low energy consumption and high levels of occupant comfort. Ventilated double skin façades reducing solar gains in summer and providing thermal insulation in winter is an example of a technology, which is becoming still more common.

Natural ventilation is one of the main advantages of the doubles skin façade systems is that they can allow natural (or fan supported) ventilation. Different types can be applied in different climates, orientations, locations and building types in order to provide fresh air before and during the working hours. The selection of Double Skin Façade type can be crucial for temperatures. If the air velocity and the quality of the introduced air inside the building is designed well, the natural ventilation can lead to reduction of energy consumption during the occupation stage and improve the comfort of the occupants.

**Sustainable Design and Context**

Context quality has always been a fundamental objective of the planning system, and good design can often resolve the apparent conflicts between the need for development and the desire to conserve the best aspects of the natural and built environment. Design is a creative activity; it depends on intelligence and fantasy, and it can put something forward which was not there before. Architects play with forms masses, functions, and structures. They do this in order to find better solutions (Farivarsadri & Alsac, 2006). Sustainable building design should establish a relationship between building and life, reducing impacts in human health. Moreover, there must be an ecological integration between human life and other species’ lives. Sustainable design is often viewed as a necessary tool for achieving sustainability; it highlights the need for setting sustainability targets, indicators, and benchmarks at a very early stage in order to prevent potential conflicts between key actors, which hinder the progress towards sustainability.

Sustainable design (also referred to as “green design”, “eco-design”, or “design for environment”) is considered a means of reducing or eliminating these impacts while maintaining quality of life by using careful assessment and clever design to substitute less harmful products and processes for conventional ones. Buildings can offer opportunities to increase habitats for greening to improve the micro-climate and visual amenity of an area. This is achieved by the use of roof gardens or green roofs, climbing plants on walls, window boxes and balcony gardens. In Richard Rogers’s design works, nature is allowed to colonize the interior spaces, the roof tops and the surrounding landscape. The justification is that of conservation but the effect is to uplift the spirit by making nature immediately visible. For Rogers, nature is both an aesthetic tool and a source of delight, necessary to humanize cities (Edwards, 2001).

We are surrounded by a built environment. Buildings are essential to human beings for living, working and multiple other activities. According to Vitruvius (qtd in Looman, 2007), one of the most fundamental functions of architecture is to provide shelter from the dynamic conditions of our environment. He also mentioned concerning the
building’s environment as a design parameter, “we must at the outset take note of the countries and climates in which buildings are built”. So, architecture initiated from function, local climate and availability of local resources. A key design policy consideration is that development responds appropriately to its context, but that context is defined to include the visual, social, functional and environmental dimensions. Concerned with how development fits into its social, economic and ecological context, how it deals with the activities and flows of people and traffic that a development generates, the spaces it creates its impact on the natural processes of the city.

Conclusions

There is a world-wide need for a sustainable development, which strongly emphasizes the importance of engaging architects and encouraging good contemporary design, recognizing importance of not stifling experiment, originality or initiative, to ensure quality architecture that respects its context, enhances the sense of place, provides visual interest for future generations, and which will support the principles of sustainable development. Moreover, as environmental guardians, architects also have a duty specifically to encourage more sustainable approaches to building design. Thus policy should make clear an authority’s acceptance of the visual consequences of sustainable objectives, and should wherever possible encourage sustainable construction. Good design is the aim of all involved in the development process, but it is primarily the responsibility of designers and their clients. Final building design has to meet a variety of design objectives (such as comfortable indoor climate, healthy environment, life-cycle costs, resource use, environmental loading, functionality and architectural expression) that are interrelated. This demands that consideration of all objectives should be applied from the very early stages of the design process, by full understanding of the interrelationships between the different design objectives and close cooperation among all designers (architects and technical designers) of the design team in an integrated design approach where all available knowledge is shared.

The challenge is to create structures that remain cool in the summer and warm in the winter. In the summer, this includes keeping out the summer sun and heat and bringing in the cool breezes. Keeping a building warm in winter includes bringing in the winter sun and keeping heat in and the cold winds and temperatures out. One needs to identify local conditions and microclimates, by applying more demanding environmental criteria including the study of prevailing winds and breezes, and various microclimates created as a result of surrounding buildings or topography. Identifying regional and local climatic conditions is always a most suitable point of departure in attempting to create an energy-efficient building, for saving the environment and reducing building reliance on fossil fuels.

Architects must be mindful of multiple concerns in designing building facades. There are always trade-offs that must be made in optimizing building facade performance and the challenge lies in balancing conflicting criteria. A desire to maximize transparency, daylight, and views, for instance, can often be at odds with the need to minimize solar heat gain and reduce air-conditioning loads. Double skin facades are an appropriate approach to maximizing the positive qualities of glazing while minimizing its negative energy impact and its potential for thermal
discomfort, especially on easterly or westerly glazed facades.

Design considerations indicate how buildings should perform from both a user and a sustainability perspective comprehensively, which draws together the full range of sustainability concerns: location and form, movement, natural systems and building design. The key design considerations remain how the proposed development relates to its surroundings and all developments must respect their surroundings. In environmentally sensitive areas the context can exert a more powerful influence upon design, and a more detailed level of controls acceptable. Still, many buildings hardly comply with standard building codes and regulations are yet to be incorporated in the building planning phase.

Sequentially from the previous analysis, we can conclude an assessment method including sustainable design guidelines, comprising a set of indicators specifically selected from the economic, social and environmental subsets to assist the refinement of design brief sustainable indicators appropriate for applications to design.

For architectural design criteria the following issues including form, orientation, lighting, transparency, cladding and opening percentage should be well studied. For urban design elevations, exposure (grouping of buildings) and street width should be incorporated effectively into the design process. For energy design control the walls, roofs design, materials, textures and energy building codes should be taken into design considerations. For environment design, water, greenery, roof gardens, atriums, and climatic control systems should be well adapted and utilized in the design process. Hazardous materials should be excluded and minimized as possible including (toxic, chemical, mechanical, and waste) emissions. For social and economic values culture norms and architectural style, low energy consumption should be the aim in design to provide low maintenance utilities cost.

Environmental design and construction community must become actively engaged in writing code change proposals and encouraging funding research and testing to support those changes. Building community needs to share their direct experience in contending with the realities of those standards by participating more fully in the standards-development process.

It is recommended that sustainable development should be a principal goal of design at all scales, and should take into account both differential environmental capacities and sustainable to develop a conception of urban/environmental design that embraces notions of the values that people ascribe to the built and natural environment. The social and technological development and the ecological equilibrium must walk together promoting clean technologies reviving traditional design concepts and adapting modern solutions like double skin facades, without any ecosystem’s aggressions, by incorporating eco-design applications in the design.

Design policies and proposals should recognize the severe limitations of negative controls and seek to promote an overall climate for good design, encouraging design creativity by engaging skilled architectural advice and encouraging high design standards, developments as well should be tailored to encourage healthy living and mutual coexistence with the environment.
References


Ibrahim Mostafa Eldemery

Ibrahim Mostafa Eldemery is an Assistant Professor in the Department of Architecture at the National Housing & Building Research Center in Egypt. Research interests, designs and teaching include architectural theories and modern movements applications and its impact on cultural heritage and aesthetic values in architecture. Received MSC. & PH.D. thesis in Architecture from the Faculty of Architectural Engineering, Cairo University in Egypt. Team consultant in several researches for the improvement of the New Urban Communities Housing Projects in Egypt. Published several articles in the field of Architecture in National & International conferences and Journals. Working as a consultant and project coordinator for several projects of several Design projects and research works. Participating and winning Prizes in Architectural competitions. Participating in the preparation and implementation for National and International Training courses, and providing technical inputs in training and advisory services in the field of architectural project management. Email address is: imeldemery@hotmail.com