ENVIRONMENTALLY RESPONSIVE DESIGN IN ARCHITECTURE WITH KEN YEANG'S DESIGN AGENDA UNDER FOCUS

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ERAY BOZKURT

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T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

Approval of the Graduate School of Natural and Applied Sciences.

Prof. Dr. Nayfur Öztürk

Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Architecture.

Assoc. Prof. Dr. Selahattin Önür

Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Architecture.

Assoc. Prof. Dr. Mualla Erkılıç

Supervisor

Examining Committee Members

Prof. Dr. Vacit İmamoğlu

Assoc.Prof.Dr.Mualla Erkılıç

Assoc.Prof.Dr.Demet Irklı Eryıldız

Inst. Dr. Rana Nergis Öğüt

Inst. Uğur Yalçıner

ABSTRACT

ENVIRONMENTALLY RESPONSIVE DESIGN IN ARCHITECTURE WITH KEN YEANG'S DESIGN AGENDA UNDER FOCUS

Bozkurt, Eray

M.Arch., Department of Architecture

Supervisor: Assoc. Prof. Dr. Mualla Erkılıç

Co-Supervisor: Assoc. Prof. Dr. F. Nur Demirbilek

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This thesis analyses *environmentally responsive design (er design)* in architecture. The issue, being increasingly relevant and rather compulsory due to problems faced in the natural environment and in energy, is examined through its constituent parts. Though still not influentially present in collective global consciousness, *er design* is nevertheless evaluated through a theoretically explanatory system of thought with the aid of various references.

The environmentally responsive architectural works of Prof. Dr. Ken Yeang, with whom I worked in Kuala Lumpur, Malaysia, for some time, are integrated into the thesis with the aim of guiding the investigation into where and how an architect could employ this design method throughout a design process.

The primary aim of this thesis is to analyse *er design* in architecture in a specific manner, in addition to being a contributor to all other academic works which intend to examine this design method in order to enhance architecture at the service of

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society, and to participate in influencing the application of the profession by presenting fresh thoughts and knowledge.

Keywords: er design, environment, energy, awareness, methodology, knowledge, practise.

ÖZ

ÇEVREYE DUYARLI TASARIM ANLAYIŞININ PROF. DR KEN YEANG'IN MİMARİ ÇALIŞMALARIYLA BİRLİKTE İNCELENMESİ

Bozkurt, Eray
Yüksek Lisans, Mimarlık Bölümü
Tez Yöneticisi: Doç. Dr. Mualla Erkılıç
Ortak Tez Yöneticisi: Doç. Dr. F.Nur Demirbilek

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Bu tez çalışması, mimarlıkta çevreye duyarlı tasarım konusunu incelemektedir. Günümüzde doğal çevre ve enerji sorunları dolayısıyla gereklilik *ve* zorunluluk haline gelen bu tasarım anlayışı, onu oluşturan çeşitli yönleri ile araştırılmıştır. Kaynaklardan yararlanılarak, artan önemine rağmen henüz geniş bir kitleye ulaşamamış bu olgu teorik olarak açıklayıcı bir sistem oluşturularak incelenmiştir.

Malezya' nın başkenti Kuala Lumpur' da, yanında bir süre çalıştığım Prof. Dr. Ken Yeang' in çevreye duyarlı tasarıma yönelik mimari çalışmaları mimarın tasarım aşamalarında bu tasarım yöntemini nerede ve nasıl kullanabileceğinin araştırılmasında yol gösterici olarak teze dahil edilmiştir.

Bu çalışmanın esas amacı, mimarlıkta çevreye duyarlı tasarım konusunu bilimsel bir araştırma ile incelemek olduğu kadar, bu tasarım yöntemini akademik ortamda teorik olarak inceleyerek mimarlığın topluma hizmetine ve mimarlık mesleğinin

uygulanmasına katkıda bulunmak amacında olan diğer çalışmalara yeni yaklaşımlar ve bilgiler sunmaktır.

Anahtar kelimeler: Çevreye duyarlı tasarım, çevre, enerji, metod, bilgi, uygulama.

To my parents and brother

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CHAPTER 1

INTRODUCTION

1.1 THE DEFINITION AND DISCUSSION OF THE PROBLEM

Environmental and energy problems have reached a state of significant global importance. These problems are no longer confined to local areas, and do extend across national boundaries. International debates have attempted to foresee and prevent potential changes in climate that may be harmful to the well-being of mankind. Over recent decades scientists have become increasingly concerned about the ozone layer. It is getting thinner due to the emissions from non-renewable energy sources. Following the discovery of an ozone hole in the atmosphere over Antarctica in 1986, scientists found credible evidence that the depletion of this layer was caused by the presence of chlorine atoms in the stratosphere (Langston 97, p.14). The *Ozone layer*, a layer of protective gas which absorbs ultraviolet radiation of the sun, is vital to the health and well-being of all living creatures. It is produced by electric discharge either naturally by lightning and is toxic, corrosive and has a strong sharp odour.

Another environmental problem that is causing changes in climate is the *greenhouse effect* - a global process in which carbon dioxide and other gases build up in the atmosphere, and trap increasing amounts of the sun's heat. Increase in the amount of solar radiation retained in the atmosphere causes *global warming*. The effects of *global warming* include the escalation of global sea-level and draughts; either of which could have severe consequences for global food production. (Edwards 1998, p 25). The warming of the Earth's surface has a

significant effect on living creatures as well as the structure of the atmosphere. It influences patterns of climate. Higher temperatures tend to speed up evaporation in some regions and therefore cause more precipitation in others. A warmer atmosphere retains more moisture, and water vapour absorbs more radiant heat. Additional water vapour in the air will result in more rain and this cycle inevitably enhances the greenhouse effect (Falk,J. and Brownlow, A., 1989, p.57).

In the year 900, 40 per cent of the Earth's surface was forested. Today, only 20 per cent of the Earth's surface remains forested, and these forests are vanishing at accelerating rates. *Deforestation* has been an on-going activity that has increased significantly in effect since the Industrial Revolution. Forests have been cleared and used for agriculture and construction of urban areas. This continuous *deforestation* has gradually begun to disrupt the Earth's equilibrium.

Biodiversity means the variety and variability of all animals, plants and lower organisms within a given area. The exact number of organisms is not known but it is believed to be approximately 5 to 30 million, of which only 1.4 million have been identified (Wilson 1989, p.57). The greatest threat is the loss or disruption of natural habitats due to *deforestation*. The loss of the rainforests means that less sunlight will be absorbed and more stored carbon will be released into the atmosphere which in turn will increase global temperature.

Fossil Fuel Energies is another world wide threat, which is closely linked with environmental degradation. Credible evidence of the warming of the Earth's surface, as a result of an unprecedented increase in the atmospheric concentration of greenhouse gases, caused by non-renewable **fossil fuel energies**, has required international cooperation to reduce the production of these harmful gases. The main objective is to raise international awareness and collective effort in solving environmental problems, and to avoid delaying this issue for future generations to tackle. International cooperation can be observed in various events [1].

[1] See Appendix F.

Energy is essential to all human activity, and is vital for human productivity. Modern society has evolved with great speed since the Industrial Revolution, and has become increasingly energy dependent. **Energy** is a political issue due to living standards depending on it. The level of control of global energy resources determine the scope of influence of the institutions controlling them. The price of oil and natural gas has become a key factor in global economy. Petroleum products are the main fuels of the industrialised nations, and oil exploration and recovery depends on the price as does the development of methods of improved recovery rate (Wilson 1989, p.55). Additionally, non-renewable fossil fuel sources will not last long and thus alternative sources are required to maintain current consumption. As a result, the next 100 years will undoubtedly see a gradual change in the current central role of non-renewable energy sources in industrial economies. It is still not clear what will replace them, since nuclear power possesses a number of economic and environmental draw-backs, and the renewables do not match non-renewable sources in terms of feasibility (Wilson 1989, p.57).

According to Nazli Choucri from MIT University, the problem currently seems to be that:

> Traditional patterns of industrial and economic activities are no longer viable, but alternative models are not yet developed either. The historical trajectory of the industrial west cannot serve as a model for developing countries. Ecological systems are severely strained by the cumulative effects of past industrialisation and can scarcely support additional strains due to projected patterns of growth. There remains major uncertainties about what must be done, and how. The international community as a whole is involved in a global search for new modes of development, new designs for social interaction, and new technologies for meeting evolving demands' (Scott 1998, p.9).

Architects have a large share of responsibility for reducing negative environmental impact and quantities of required energy to inhabit and maintain buildings. The structures of building, their service systems and their gradual adaptation to use directly influence the nature of impact on the environment. The evaluation of environmental measures is as important as issues of site planning, structure, services, spatial qualities and volumetric form. It is rather odd that architects do not seem to consider the subtle balance between buildings and climatic factors. It is

probable that the technical issues of design work are conceived as being more dominant than the spatially architectural aspects.[2]

It will take sometime to replace the current living conditions with alternative ones. Scientists are working on renewable energy sources which are at the moment can not sustain the man-made environment. However, current living conditions will still cause environmental degradation. There is an urgent need to analyse the current built environment to modify the way there are built to more environmentally friendly ones.

1.1.1 The Various Effects of the Built Environment on Environmental and Energy Problems

One could observe three main considerations throughout the history of environmental sensibilities in built environment. One of these might be identified as *buildings' relationship to climatic forces* like sunshine, wind, rain and snow. The second might be the *resources*, that is, the means with which the buildings have been constructed down the ages. Final consideration is the *historical relationship between architecture and environment.*

Climate has been an important factor ever since man first constructed shelter. Throughout architectural history, local builders have used techniques in providing the most comfortable internal conditions possible within the constraints of local climates. For example, in hot regions, evaporative cooling is induced by accelerating airflow through and across spaces; temperatures are reduced by ensuring that direct sunshine can't penetrate the building; and thermal capacity of massive structure is used to insulate and take up the heat during the day and release it at night when it is cooler. Similarly in cold regions, the insulating quality of materials is exploited and solar heating encouraged. Architects have found ways of enhancing and manipulating daylight, and contriving shelter from cold winds. In temperate regions, buildings tend to employ a combination of these measures, the particular mix tuned to suit local climatic characteristics.

[2] http://ntua.gr/arch/geometry/tns/20years.htm

However not all buildings give such importance to climatic factors. Larger buildings, those with complex functions, tend to give less importance to harnessing natural forces to provide comfort. This can be observed in today's complex multifunctional buildings such as shopping centers and airport terminals where recourse is made to artificial rather than natural forces.

In vernacular building, there was little option but to use local *resources* and to use to maximum benefit. As societies prospered, architects had increasing access to greater resources. Throughout history, wealth and scope of influence has determined the amount of resource available to any building project.

Replaceable and maintainable resources include water as well as flora and fauna. In natural conditions such resources will be produced indefinitely. Any impairment of the environment will have an adverse effect on the production of replaceable and maintainable resources (Yeang 1999, p.146).

Irreplaceable resources are minerals, soil, fossil fuels, land and the landscape in its original state. Irreplaceable resources' availability is related to the rate and type of exploitation by mankind. The present rate of consumption of irreplaceable resources by mankind is greater than the rate of natural regeneration (Yeang 1999, p.147).

Renewable energy resources include the flow of precipitated water, tidal effects of the oceans, geothermal factors, wind power, climate energy, photosynthesised energy and waste products recycled as fuel (Yeang 1999, p.149).

The third consideration in the tracing of the history of environmental sensibilities involves the historical relationship between built environment and natural environment. In the past, small populations and modest requirements for energy utilisation meant low emissions, mainly related to combustion processes. The waste products of past centuries were recyclable and biodegradable and posed no threat to the environment. Almost all waste could be returned back into the cycle of Nature.

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Before the 19th century, ample potential energy in the form of coal, oil and natural gas were known. Coal was used to warm the soldiers on the Hadrian's Wall, and natural gas piped through bamboo stems lit the streets in a few medieval Chinese cities (Simmons 1991, p.42). The realisation of the potential of the steam engine, causing increase in the price of both timber and labour, coinciding with the new process of melting iron led to the remaking of the relationship between mankind and his built environment. Following the wide spread employment of metal and chemical technologies, previously unknown materials such as carbon fibre and superconductors began to be used. The consequences have been enormous and so complex as to defy easy categorisation. Nations undergoing industrialisation have experienced explosive growth of their cities. (Simmons 1991, p.44).

After the industrial revolution, the need for shelter has increased for various reasons such as migration, wars, increase in population, industrialisation, change in family structure, the sheer physical wear of existing buildings and their additional incapability to meet new requirements.

Coal was the founding fuel of the industrial revolution. and has been responsible for the creation of many industrial areas and cities throughout the world. Coal has nearly all C, H, O and N gases with variable amounts of sulphur. Oil, natural gas and natural gas liquids are often found together and often nowhere near the older established industrial centres. These sources contain sulphur, mostly in oils. Oil. In turn. is easy to transport in bulk by tanker or pipeline, but for maximum value has to be refined into component chemicals before use. Several of these components are not used for the production of energy, but provide the stock materials for plastics and some pharmaceuticals (Simmons 91, p.54).

The use of fossil fuels gave societies many tools with which to influence their surroundings. Insufficiency in building production has resulted in the appearance of shantytowns, causing social and subsequent political problems. Housing estates were built to solve the problem of the shelter. Increasing amounts of energy and resources had to be spent on the modernist concepts of construction.

Industrialisation process remained. and new urban cities with more than one million inhabitants rose.

New building technologies were developed to offer better environment in the shelters. Air conditioning systems were introduced to grant thermal comfort artificially. However, these mechanical systems produce emissions that have harmful effect on the natural environment. The amounts of emissions are in such ample levels that they could not be returned to natural cycle in their entireties.

1.1.2 International Cooperation

In 1973, after the Yom Kippur War, Arab nations placed an embargo to the developed countries which supported Israel. This led to a collective awareness in the industrialised west of the extent of their dependency on fossil fuels. However, it wasn't only the energy crisis, but also environmental impairment caused by the emissions of fossil fuels that came under consideration. On 28 June 1979, with the turmoil in Iran after the fall of Shah, the OPEC countries met at Geneva and raised oil prices by 15 percent, which were already escalated 14 percent two months earlier. Another oil crisis had dawned, with rationed petrol queues outside fuel pumps in countries dependent on Middle Eastern suppliers. This was not the first time that Western countries had been alarmed by an actual or perceived threat to the supply of their energy. The Suez crisis in 1956 contributed to the initiation of an atomic energy programme in the UK and some other European countries, and occasional conflicts between Israel and Arab nations promoted further jitters. The 1979 crisis, though, coincided with the growing concern over the effects of technological development and the consequences of exponential growth in energy demand on the Earth's ecology, and on the survival of life on the planet (Jones 1998, p.24).

One might argue that this issue also led to the gradual global awareness of the fragility of the divide separating the affluent, energy hungry nations from those of the deprived Third World.

Energy consciousness brought awareness to the public of not only environmental issues, but also that limited energy supply would have a rather major impact on current living standards. As the crisis was overcome in 1981 and the OPEC countries were forced to reduce prices, governments of industrialised nations took measures to attempt to ensure that they would not have to experience such a crisis again. One of these measures was to consider alternative forms of energy sources more seriously. With this central issue on the agenda, the International Energy Agency (IEA), set up in 1974 after an earlier oil crisis by the countries of the Organisation for Economic Cooperation and Development (OECD), introduced a series of tasks to research, develop and promote alternative energy sources[3].

By the early nineties, environmental design issues began to occupy a greater priority on the international agenda. Faced by the problems posed, world leaders agreed at **the Earth Summit at Rio de Janeiro in 1992**[4] to take measures to reduce fossil fuel emissions, to develop a strategy of sustainable development, to protect the remaining rainforests, and to maintain the biodiversity of global ecosystems.

In **Agenda 21** of the Rio Earth Summit, issues of sustainability and sustainable development were portrayed being in direct relationship to architecture, and were accepted as a member of the primary concerns of national and municipal governments (Powell 1999, p 69).

Architects were invited to re-evaluate the potential impact which environmental considerations could have on their works. It was presumed that such measures could contribute in a conforming manner to a building's design; that considerations of passive and active control methods, such as orientation, natural ventilation, use of daylight, solar control and thermal comfort could reduce built environments' negative impact on nature.

[3] See Appendix E.
[4] See Appendix. F

Subsequently, these issues were taken onboard in the **International Union of Architects (UIA)**[5]. At the **18th UIA/AIA Congress of Architects (1993)**[6], growing concerns about the future of global environment and resources were raised. 'Energy consumption, global warming and pollution are significant factors and the key issue is how to solve the problem of rapid urbanisation and management of cities' One interesting point of the debate was that several architects and architectural firms had put forth their individual guidelines and declarations. William McDonough, for example, prepared the **Hannover Principles.**[7] (Ozkeresteci 1999)Thus, the congress did not result in the establishment of common attitudes between architects towards environmental ends and energy conservation.

At the eve of the new millennium, architects from all over the world gathered in Beijing for **the 20th Congress of the UIA**[8]. The central theme were the challenges facing the profession in the 21st century. The underlying aim of the Congress was the definition, recognition and the establishment of collective principles among architects around the world in order to maintain environmental consciousness at both local and global scales.

Further programme of UIA congresses will continue to focus on the issues of sustainability and sustainable development. The overall theme for **21st Congress of the UIA (2002)**[9], which will take place in Berlin, will be 'architecture as a resource'[10]. In 1999, **20th UIA Bejing Congress**, it was agreed that 22nd UIA Congress(2005) will take place in Istanbul. The theme will be decided in Berlin

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[5] The **International Union of Architects**: is an organisation embracing all the architects of the world through the professional associations of their respective countries. Created in June 1948 and with its permanent headquarters in Paris, the organisation is officially recognised by UNESCO, by which it is normally required to deal with questions of an international nature related to Architecture. The **International Union of Architects** has eighty-six member countries, is organised in five regions (Western Europe, Eastern Europe-Near East, America, Asia-Oceania and Africa) and its official languages are French, English, Spanish and Russian. Every three years, the International Union of Architects holds a Congress on a topical theme of interest related to architecture and urban planning. Furthermore, it grants the UIA Gold Medal and the following four awards: "Sir Patrick Abercrombie" for urban planning and territorial improvement "Sir Robert Matthew" for improvement to the quality of human settlements "Auguste Perret" for technology applied to architecture "Jean Tschumi" for architectural criticism or teaching (http://www.arquired.es/angles/uia.html).

[6] See Appendix C.

[7] See Appendix D.

[8] See Appendix B.

[9] http://www.uia-architectes.org/texte/news/2berlin2002.htm.

[10] See Appendix H.

2002. However, the issues sustainability will be valid for this congress and more consequences will be faced from environmental and energy problems if necessary precautions are ignored.

1.1.3 The Context of Turkey

Turkey is a developing country in which rapid industrialisation began after the Kemalist Revolution. The model for growth in Turkey has generally been an interpretation of that of the industrialised West. This interpretation could be summarised as the exploitation of the available natural resources for the sake of rapid industrial development. Although industrialisation in Turkey has started much later than the industrialised West, current rate of exploitation of resources will soon result in equivalent environmental problems.

Awareness of environmental and energy issues in architecture has begun very recently and peaked since the 1992 Rio Earth Summit. Many attending countries have not yet been able to apply adequate measures at greater scales. In Turkey, for instance, the required collaboration for this application does not exist between the government, academic institutions, the industry, and architects as required. In any case, there seems to be no demand for such measures due to the relative unawareness of the public about this issue.

Architects do have a role to influence the public with their approach to building design. majority of architects prefer to use conventional methods which in the short term reduce a building's final cost, which in turn increases long term management and maintenance costs.

Recent energy related problems in Turkey could inevitably lead to a demand for *er design*. In this respect, the Turkish government needs to take decisive steps to educate the public on the benefits. Current attempts seem to be address to motivate the public.

The implications of the Marmara Earthquake in 17th of August 1999, have contributed to the increase in the awareness of improper constructions. After the earthquake survivors began to live in tents, which was perceived by the public as a lower standard of living. These were rather primitive shelters with no proper heating and protection from draughts.

There are few architectural offices in Turkey that give priority to design strategies in solving environmental and energy related problems. For instance the Turkish Pavilion at Expo 2000, designed by Tabanoglu Architecture and Consulting firm[11]. In the project, there is an attempt to use environmental control system. Evaporative cooling method is used to cool down the air, which later entered through the louvres in the glass wall. Then, the air rises to be expelled through the plexiglass pyramids in the roof (AJ Sep 2000, p.76). The building received significant attention, for this clearly articulated environmental control system compare to any other at Expo (AJ Sep 2000, p.76).

Güven Arif Sargın's article in September 1998 issue of Arredamento Mimarlık magazine, summarises the recent attempts for er design in Turkey . He states that although there are few examples of 'green architecture', because of Anatolia's cultural richness and varieties of ideas, architects have begun to design more environmentally sensitive or 'green buildings' (Sargın, Arredamento Mimarlık, Sep 1998, p.84). The leading architects, Turgut Cansever, Cengiz Bektaş and Öner Tokcan, try to form their unique interpretations for green buildings, completed projects that were recognised by international agenda (Sargın, Arredamento Mimarlık, Sep.1998, p.84).

One might argue that this awareness will gradually initiate a collective consciousness regarding the presence and influence of architecture and built environment in daily life. The Turkish government needs to address environmental problems on a national scale.

[11] See Appendix I.

There are some significant attempts to bring awareness by organising national conferences. In year 2000, there were two conferences took place about energy and environment in Middle East Technical University. Between 8th of May and 12th May 2000, World Energy Council's Turkish National Committee organised the 8th Energy Conference under the title ' Energy and Technology for Continuous Development in 21st Century'. First conference was organised in 1956 and till now only eight conferences organised. Suleyman Demirel, the former president in his opening speech, said that although energy is crucial problem in Turkey, not enough energy conferences prepared in last forty-four years.

The 8th Energy Conference wasn't really about reducing energy use. The topics mainly about the technological developments on energy production. Even Suleyman Demirel suggested on increasing the amount of energy production by building more damps or nuclear energy plants.

Second conference organised at METU, between 4th and 6th of October 2000 was about environmental degradation caused by manufacturing industry. The built environment's effect is confined to engineering projects rather than architectural ones.

'Third National Clean Energy Symposium' was organised by Istanbul Technical University between 15th and 17th of November 2000, had six presentations from the architectural field[12].

1.2 THE AIM AND THE STRUCTURE OF THE STUDY

The primary aim of this thesis is to analyse *er design* strategies as an important issue in architectural design process. As the methodology to do so, I will assemble an inquiry into the technical and theoretical aspects of *er design*. Additionally, I will scrutinise the design issues referring to my professional experience in this field, and try to conflate my practical and technical knowledge with the academic one. I will

[12] See Appendix J.

refer to my professional experience which I gained while working with the architect Ken Yeang.

The methodology employed in this study attempts to assert that the knowledge gathered through 'research by design', that is, research carried out during the professional practice of architecture, is as vital as the knowledge gained through theoretical and analytical studies by the academic milieu.

I will re-construct my professional knowledge in a systematic manner and employ it as **applicable knowledge** in order to enhance the design process of *er design*. Throughout this survey, the **preliminary**, **developing** and **final stages** of the architectural design processes of some projects will be examined as case studies in an attempt to clarify the objectives and design strategies regarding *er design*.

In chapter one, environment and energy related problems are defined, and current attempts to tackle them explained in international and Turkish context.

In chapter two, after a rather broad discussion of the environmental attitudes in architecture, I will concentrate on the **design process** and identify ideas, concepts and strategies significant in achieving *er design* solutions. These concepts and strategies will be mainly related with passive methods rather than active ones.

In chapter three, *er design* considerations discussed in the second chapter will be related to the design works of Prof. Dr. Ken Yeang[13]. Prof. Yeang is well known for his regionalist and ecologist approach to building design. He favors a design

[13] **Prof. Dr. Ken Yeang** was born on Penang Island off the north coast of Peninsular Malaysia in 1948. In 1961, he was sent to boarding school Cheltenham College in England. In 1966, he took the first steps towards a career in architecture, gaining a place at the Architectural Association School of Architecture (AA). There he was tutored by influential architects of that period, Elia Zenghelis, Ron Herron, Peter Cook and others. In 1971, he completed his education at the AA, then continued his Phd degree at Wolfson College, University of Cambridge. There he wrote a doctoral thesis titled ' A Theoretical Framework for Incorporating Ecological Considerations in the Design and Planning of the Built Environment', later published as a book under title 'Designing with Climate(1995)'. After he completed his education in England, he went back to Malaysia to form his practice with Tengku Robert Hamzah who was his colleague at the AA. Yeang's arrival back in Malaysia coincided with a period of extensive Malayanisation. During that period he wrote 'Tropical Urban Regionalism', 'Tropical Verandah Cities' and 'The Architecture of Malaysia'. His office 'Tr. Hamzah and Yeang Sdn Bhd' based in Kuala Lumpur, worked on numerous projects mainly in Asia and some in Europe.

approach that takes into account the architectural and natural characteristics of the given regions, especially their climates and ecology, and employs innovative technologies in his designs. His ability to transform theoretical ideas of *er design* into physical reality receive admiration from the architectural scene. Michael Sorkin describes Ken Yeang as:

> The complete architect for this difficult moment on the globe. Yeang is to the architecture profession what the grand unification theory is to physics – our best shot at the big picture. His unique mediated sense of critical regionalism is sensitive to climate and economics as well as to culture (Powell, 1999).

Yeang's design methodology will be analysed through some of his projects in both Malaysia and Europe. This methodology was initiated during Yeang's PhD studies and led to the establishment of the essential agenda for his later professional work (Powell 1992, p.17). To understand Yeang's design methodology and attitude towards ERD, his architectural education, his books and his design proposals will be examined. I will also employ my personal knowledge which I gained while working in his office between July 97 and May 98. My experience will provide eyewitness information about his progress in *er design* method.

CHAPTER 2

2.A CONCEPTUAL FRAMEWORK: DEFINITION AND STRATEGIES FOR ENVIRONMENTALLY RESPONSIVE DESIGN

In chapter one, environment and energy related problems which threaten Earth equilibrium, were discussed. In order to solve these problems, one necessary step is to replace *fossil fuel energies* with *renewable clean* ones. However, current renewable energies are not feasible and capable to meet increasing energy demands of the built environment. It will take some time for alternative energies to replace with fossil fuels.

One might argue that it is the builders' (that is, professionals engaged in the design and making of the built environment) job to replace the conventional methods of building with that of the *er design*. This could be enabled only through an awareness of these issues in the consciousness of the people directly in charge of the process of the construction of the built environment and its users.

There are various conscious attitudes dealing with environment and energy related problems such as *climate conscious*, *bioclimatic*, *sustainable*, *ecology* and *energy conscious design*. These all contribute to structure of *er design*, focusing on different design issues, for instance, *sustainable design* considers the use of natural resources as important. These different conscious attitudes will be analysed under the subtitle 'Various Conscious Attitudes on *Environmentally Responsive Design*' further in this chapter.

The purpose of chapter two is to assemble the knowledge of *er design* in within a framework which will encourage people working on *er design* to relate to each other

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

in a consistent manner, and to help those outside design field, for instance the clients, to perceive it. Along with the analytical survey of *er design*, the social and political strategies will be discussed in respect to the roles of governments academic institutions, and manufacturing industries in maintaining continuous consciousness.

Every experienced architect is familiar with the traditional stages of design and construction processes. At the time of writing of the book A Green Vitruvius, sponsored by the European Commission and Architect's Council of Europe (ACE), the twenty or so architects in the ACE had more than a dozen documents describing the design and construction process for a building in their countries of origin. All these are compiled together to form the 1994 ACE Breakdown which divides traditional project stages into four main categories. These are *inception stage*, *design stage*, *construction stage*, and *refurbishment stage*. During each stage, valuable environmental measures can be taken and energy conservation can be achieved. These project stages will be discussed in Part B of this chapter.

2.A.1 DEFINITION OF ENVIRONMENTALLY RESPONSIVE DESIGN

History shows that, with accumulated human experience and imagination, the architecture of the shelter evolved into diverse solutions to meet the challenges of widely varying climates. Vitruvius, the Roman architect who was active in the first century BC, wrote a book named The Ten Books On Architecture, a seminal text for most of the architectural styles. In this book, Vitruvius underlined the importance of designing according to regional environment conditions. His approach towards climate can be said to stand at the foundation of *er design*.

Vitruvius stated:

> The architect should be equipped with knowledge of many branches of study and varied kinds of learning, or it is by his judgement that all work done by the other arts are put to test. This knowledge is the child of practice and theory. Practice is the continuous and regular exercise of employment where manual work done with any necessary material according to the design of a drawing. Theory on the other hand, is the ability to demonstrate and explain the production of dexterity on the principle of production (Vitruvius 1960, p.5).

One might add to Vitruvius' words that architects of today also need adequate knowledge to deal with the challenges presented by environment and energy related problems. *Er design* methodology is capable of providing the necessary information, theory, policies, regulations, standards, services and practices to tackle the environmental problems caused by the built environment. What the design discipline needs, is the interconnection between theory, research and practice, all contributing to the assemblage of the methodology of *er design*. Practice puts the theory into reality, and research provides the necessary information.

Well-structured methodology could aid architects in merging environmental issues with aesthetic considerations in their designs. That's what distinguishes architecture from the engineering field. As Le Corbusier described:

> Architecture is the masterly, correct and magnificent play of masses brought together in light, the task of the architect is to vitalise the surfaces which clothe these masses, but in such a way that these surfaces do not become parasitical, eating up the mass and absorbing it to their own advantage: the sad story of our present-day work (Le Corbusier 1970, p.37).

The architectural image of *er design* has not yet acquired a distinctive character in comparison to conventional styles. Energy and environment may be seen as important issues, but there are also other equally important requirements to consider, particularly aesthetic ones.

David Lloyd Jones in his book, Architecture and the Environment, criticised architects for not addressing aesthetic issues in their environmental designs. David Lloyd Jones states:

> Since consideration of environmental issues is innate in all building design, although generally not satisfactorily realised or overtly expressed, it is difficult to argue the case for a Green aesthetic in the same that one might recognise post-modernism deconstructionism or any other 'ism'., Furthermore, a heightened environmental approach to architecture involves, as we shall see, a sensitivity to nature which may be manifest in ideology, physical form and detail, or in symbolic content. It doesn't, however, address aesthetic issues *per se* - issues such as space, light, mass and proportion- unlike Gothic, Baroque, Modernism or any other fully developed architectural movement (Jones 1998, p.13).

Architects are all those who assist in the ongoing process of transforming places at a wide range of scales and levels of complexity. This includes all contributors to *er design* from builders and building inspectors to the consultants, from structural engineers to the ecologist and planners, from landscape architects to others who specialise in *er design* All of these specialists take part in environmental design.

The architect's job is to organise strategies in the design and construction stages of a project. As Jerome Diethelm stated:

> Environmental design at all levels of complexity is a social process of purposeful, intentional environmental change, an ongoing collaborative process of- adjusting, remodelling, reforming, transforming, and guiding change in places- toward a more satisfactory condition, toward some better circumstances which serves evolving human ends whatever may be (Diethem 1998, p.106).

The design of any building could be said to derive from considered responses to *climate*, *technology*, *culture* and *site*. Consideration of environmental sustainability depends on these four issues. The *construction*, *maintenance* and *use patterns* all have significant impacts on the environment, both locally and globally. These impacts may produce effects in short and/or long term. They may contribute to irreversible changes in the world's climate, atmosphere and the ecosystems.

Er design is capable of guiding architects in shaping their responses to *climate*, *technology*, *culture* and *site*. *Er* approach to design differs from architects' traditional approach, and therefore the project site will have to be conceived to be more than just a zone of particular spatial qualities (Yeang 1995, p.35). It is also a living and functioning ecosystem (Yeang 1995, p.35). The dilemma exists between the management of the interconnections of ecological conditions and balance, on the one hand, and the social needs and priorities on the other.

2.A.2 VARIOUS CONSCIOUS ATTITUDES TOWARDS ENVIRONMENTALLY RESPONSIVE DESIGN

Er design is an approach that takes into account *climate*, *environment*, *energy*, *ecology*, *sustainable management*, *and waste management*. All these factors are represented in different conscious attitudes, like *climate conscious*, *bioclimatic*,

energy conscious, ecology and sustainable designs. Although they seem to be separate design methods, at the end, all of them contribute to the development of *er design*.

Table 2.1 Chart comparing the design modes (Yeang 1999, p.12).

	Design mode		
	Others	Bioclimatic	Ecological
Built form configuration	Other influences	Climate influenced	Environment influenced
Building orientation	Relatively unimportant	Crucial	Crucial
Facade and windows	Other influences	Climate responsive	Environment responsive
Energy source	Generated	Generated / ambient	Generated / ambient / local
Energy loss	Relatively unimportant	Crucial	Crucial / reused
Environmental control	Electro-mech	Electro-mech / manual	Electro-mech / manual
	Artificial	Artificial / natural	Artificial / natural
Comfort level	Consistent	Variable / consistent	Variable / consistent
Low-energy response	Electro-mech	Passive / electro-mech	Passive / electro-mech
Energy consumption	Generally high energy	Low energy	Low energy
Materials source	Relatively unimportant	Relatively unimportant	Low environmental impact
Materials output	Relatively unimportant	Relatively unimportant	Reuse / recycle / reintegrate
Site ecology	Relatively unimportant	Important	Crucial

Ken Yeang, in his book The Green Skyscrapers, prepared a comparison chart of different conscious attitudes, *bioclimatic and ecological design*, *conventional systems (others)* (Table 2.1). It's clear that *conventional systems* (others) ignore all *er design* strategies. *Climate conscious* is climate influenced, and *ecological design* is environment influenced. However, buildings' orientation and energy loss are crucial for both of them.

2.A.2.1 Climate Conscious

Climate conscious design considers the season and temperature changes in any region. From the viewpoint of inhabitant comfort and energy use, the climatic condition of a place is divided into negative and positive effects. The aim of *climate conscious design* is to provide protection from the negative factors of climate and take the advantage of the positive factors in order to reduce energy consumption and environmental impact caused by buildings and provide thermal comfort of the inhabitants (Goulding 1992, p.14).

The key factors for *climate conscious design* are the position of the sun, the amount of solar energy, air temperature and wind conditions. Orientation is a crucial design factor in *climate conscious design.* Site ecology is important, but material source and their output are relatively less so (Table 2.2).

Table 2.2 Chart for assessment of climate conscious design (adapted from Yeang,1999, p.12).

Design Mode	Climate Conscious
Build form configuration	Climate influenced
Building Orientation	Crucial
Facade and windows	Climate responsive
Energy source	Generated / ambient
Energy loss	Crucial
Environmental control	Electro-mech/manual
	Artificial / natural
Comfort level	Variable / consistent
Low-energy response	Passive / electro-mech
Energy Consumption	Low energy
Materials source	Relatively unimportant
Materials output	Relatively unimportant
Site Ecology	Important

Building form configuration and envelope are influenced by the climate. The climate can be analysed on three climatic data which are *macroclimate*, *mesoclimate* and *microclimate*. *Macroclimate* data is provided by standard meteorological stations, describing the general character of a region's sunshine, cloud, temperature, wind, humidity and precipitation. Local conditions such as topography, vegetation and flora and fauna conditions influence *mesoclimate data*. *Microclimate* data is investigated at the scale of the particular site in which intervention can modify the environment. This by for example, nearby buildings and vegetation (Goulding 1992, p.25).

For *climate responsive design*, energy saving is crucial and considerations are different for each global region (Table 2.3). For instance, night ventilation is very important in tropical, desert climatic zones, but relatively unimportant in tundra

regions and ice caps zones. Architects need the climate information to decide on operational systems in buildings.

Table 2.3 Energy saving measures by global regions (Yeang 1999, p.203).

Climatic zones												
Passive comfort measures	Active comfort measures	Ice Caps	Tundra	Uplands	Continental	Temperate	Mediterranean	Subtropical	Tropical	Savannah	Steppes	Desert
Natural ventilation		○	○	①	④	⑥	⑥	⑦	⑦	⑦	⑦	⑦
	Mechanical ventilation	⑤	⑤	③	③	⑤	④	⑤	⑥	⑥	⑥	⑥
Night ventilation		○	①	②	③	⑤	⑥	⑦	⑦	⑦	⑦	⑦
	Artificial ventilation	○	○	○	①	①	③	⑥	⑤	⑥	⑤	⑥
Evaporative cooling		○	○	○	①	②	③	②	②	⑥	⑥	⑦
	Free cooling	○	○	○	④	③	⑤	⑥	⑥	⑦	⑦	⑦
Heavy construction		⑤	④	④	⑥	⑤	⑥	②	②	③	⑥	⑥
Lightweight construction		③	③	②	②	③	③	⑤	⑤	⑥	④	④
	Artificial heating	⑦	⑦	⑦	⑦	④	④	○	○	②	③	①
Solar heating		②	⑤	⑥	⑥	⑦	⑥	○	○	②	③	○
	Free heating	⑦	⑦	②	⑥	⑥	⑤	○	○	○	⑤	○
Incidental heat		⑥	⑥	④	⑤	⑤	④	○	○	①	③	○
Insulation/permeability		⑦	⑦	⑦	⑦	⑥	⑤	○	○	①	③	④
Solar control/shading		○	①	③	④	⑤	⑥	⑥	⑥	⑥	⑦	⑦
	Artificial lighting during daytime	⑥	⑥	⑤	④	④	③	③	③	②	②	②
Daylight		⑨	⑥	⑥	⑥	⑥	⑥	⑤	⑤	⑤	⑥	④

○ ① ② ③ ④ ⑤ ⑥ ⑦
No importance — Very important

2.A.2.2 Bioclimatic

Bioclimatic design describes an approach to building design which is inspired by nature, and which applies a sustained logic to every aspect of a project, focused on optimising and using the environment. This logic covers conditions of site, economy, construction, building management and individual health and well being, in addition to building physics (Jones 1998, Glossary). *Bioclimatic design* follows the similar design strategies of *climate conscious design* (Table 2.4).

Table 2.4 Chart for assessment of bioclimatic design (adapted from Yeang 1999, p.12).

Design Mode	Bioclimatic
Build form configuration	Climate influenced
Building Orientation	Crucial
Facade and windows	Climate responsive
Energy source	Generated / ambient
Energy loss	Crucial
Environmental control	Electro-mech/manual
	Artificial / natural
Comfort level	Variable / consistent
Low-energy response	Passive / electro-mech
Energy Consumption	Low energy
Materials source	Relatively unimportant
Materials output	Relatively unimportant
Site Ecology	Important

The purpose of the *bioclimatic design* is to maintain *thermal comfort* conditions inside the building. *Thermal comfort* has close effect on human psychology and temperament. *Thermal comfort* works when there is a heat balance between person's body and its surrounding (Figure 2.1). The balance between the two depends on six factors. These *are air temperature, relative humidity, wall temperature, air velocity, activity,* and *clothing* (ACE 1999, p.26). *Air temperature,*

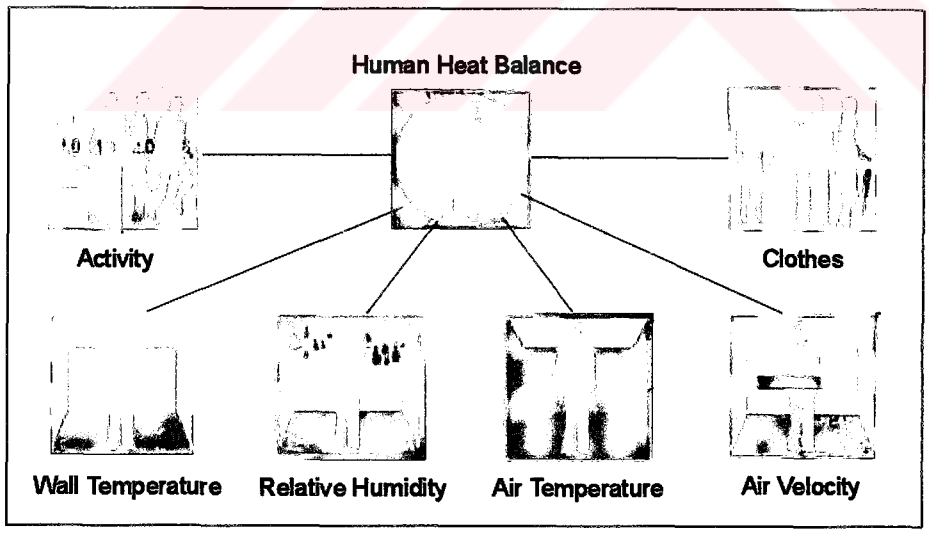

Figure 2.1 Human Heat Balance (ACE 1999, p.26).

measured with dry bulb thermometer is important to thermal comfort because more than half the heat lost from the human body is lost by convection to air (Goulding 1992, p.113). *Relative humidity* is the ratio of the amount of moisture in the air to the moisture it would contain if it were saturated at the same temperature and pressure.

It is usually recommended that the *relative humidity* in a room should be somewhere between 20%, to prevent drying up of the mucous membranes, and 80%, to avoid the formulation of mould in the building (Goulding 1992, p.113). *Air velocity*, relative to the individual, influences the heat lost through convection, can vary depending on the individual's activity. *Metabolism* is the sum of the chemical reactions which occur within the body. The aim is to maintain the body at constant internal temperature of 36.7 degrees Celsius (Goulding 1992, p.112). *Clothing* creates a thermal resistance to the heat exchange between the surface of the skin and the surrounding atmosphere (Goulding 1992, p.112).

2.A.2.3 Sustainable

Sustainability is the concept of managing the use of natural sources, so that the quantities involved are not irretrievably depleted. The development of renewable alternatives to non-renewable resources is essential and the stock of renewables in

Table 2.5 Chart for assessment of sustainable design (adapted from Yeang,1999, p.14).

Design Mode	Sustainable
Build form configuration	Sustainable
Building Orientation	Crucial
Facade and windows	Material
Energy source	Generated/ambient/local
Energy loss	Crucial/reused
Environmental control	Manual
	Artificial/natural
Comfort level	Variable/consistent
Low-energy response	
Energy Consumption	Low energy
Materials source	Crucial
Materials output	Reuse/recycle/reintegrate
Site Ecology	Crucial

use must maintained (Jones 1998, Glossary). The implication is that for development to be sustainable, it must take account not just of economic factors, but also of environmental and social factors, and must assess long term consequences as well as short term results. Building orientation, materials source and output are crucial for *sustainable design* (Table 2.5).

Sustainable development can help to promote alternative living methods. Brenda and Robert Dale defines this as ' being one which can maintain its existence of in the long term without threatening by its actions the existence of other forms of life'. Sustainability suggests there should be no irreversible pollution, no reliance on finite sources, and a stable population (Vale1991, p.43).

Holy Island Buddhist Retreat Centre Competition Project is a sustainable design project that summarises Brenda and Robert Dale's ideas on sustainability. It is designed by a multi-disciplinary team of consultants headed by the architect Andrew Wright (Figure 2.3). Wright attempted to achieve self-sustainable development for Buddhist community's way of living. The settlement aims to minimise impacts on the site, a tiny island located off the south west coast of Scotland, devoid of any connection to modernity. It ensures that any impact it does have enhances the topography, ecology and character of the island. All services, such as energy and water, were designed as self-sufficient (Figure 2.2). Water is collected from rain run-offs and distributed to the living units. All waste is processed or recycled. Waste is treated using reed beds and used for irrigation and crops, fruit, and vegetables. The building is oriented to face south, glazing is sloped to maximise solar gain, and the entire building is buried in earth and well insulated to minimise heat loss, trompe wall and thermal mass to provide 24-hour heating, sunk in ground and shaped to reduce wind exposure[1]. Electrical power is generated by wind turbines.

Buddhist people as part of their religion, don not need modern technology equipment to continue their survival. They spent their time practising their religion. This self efficient living can be seen primitive for other communities, but at the end,

[1] Paul Finch. 'Combining Technology and Nature on Holy Island', Architectural Journal 18 April 1996, p 32-41.

they continue their survival without depending on finite sources and contributing positive effect to environment and energy problems.

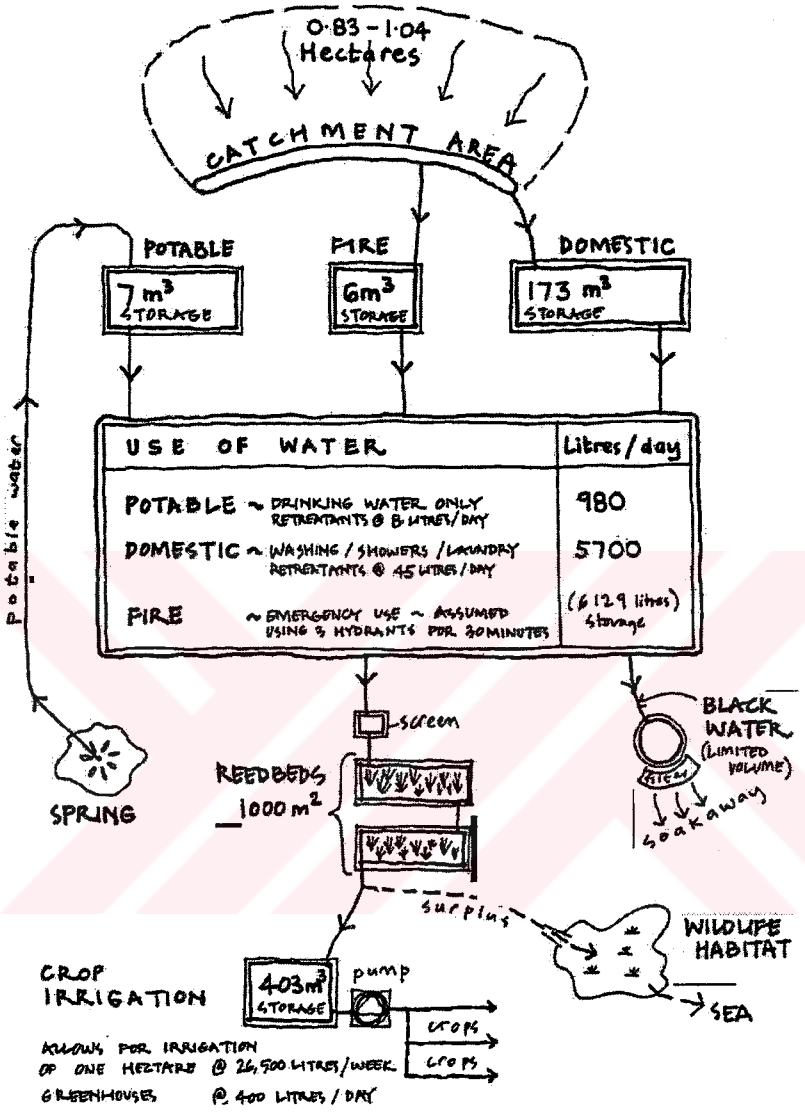

Figure 2.2 Sketch of the design strategy of Holy Island Project (AJ Magazine, 18th of April 1996, p.34).

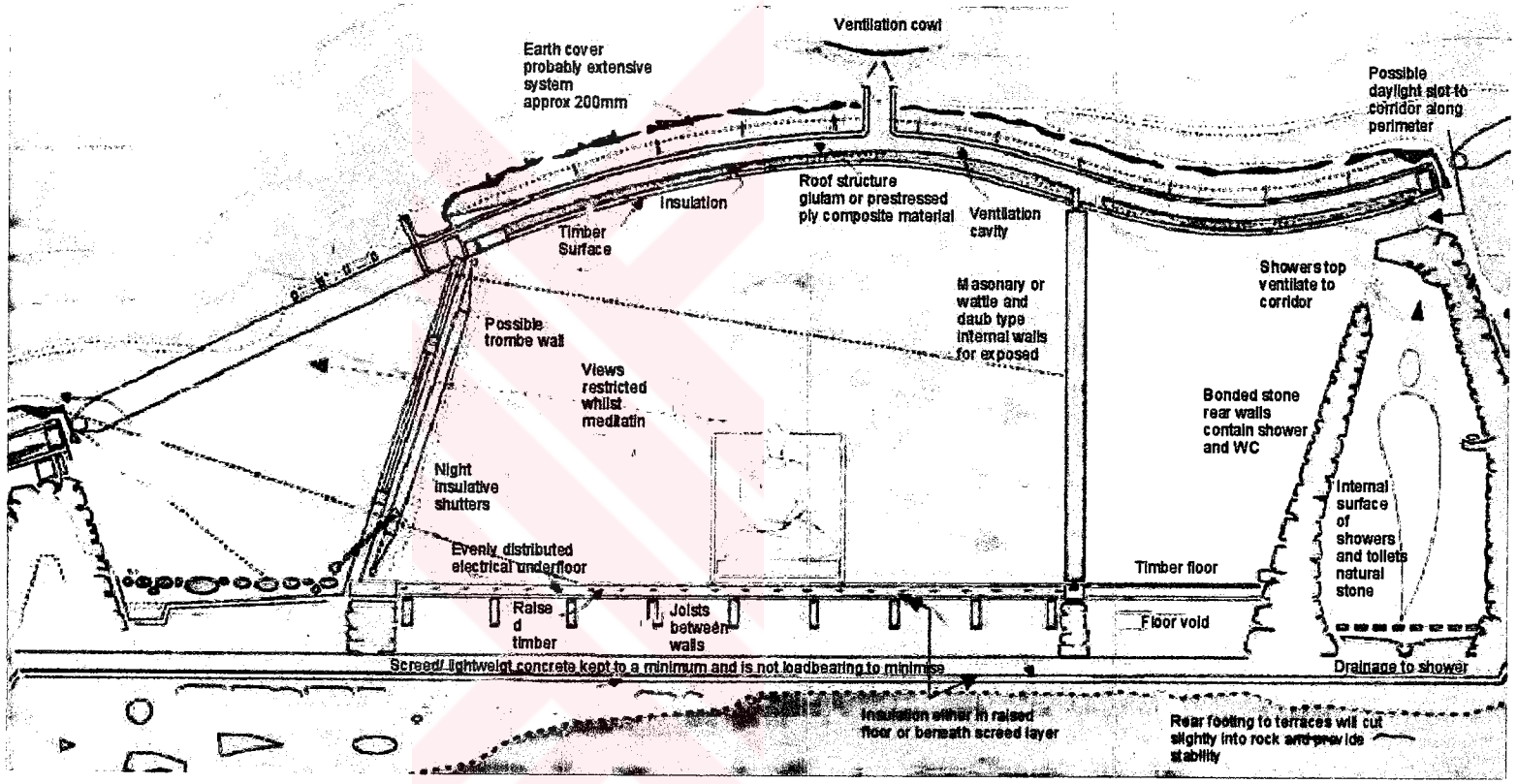

Figure 2.3 Part of the long section on Holy Island Sustainable Development Project (AJ Magazine, 18th April 1996; p34)

2.A.2.4 Ecological

Ecological design begins with the intimate knowledge of a place, so that design strategies are responsive to local conditions and people. *Ecological design* is an understanding of the basic systematic concepts of ecology and their applications with minimum disruption of the ecosystem, with economical use of the Earth's non-renewable *resources* and with activities associated with the designed system symbiotically compatible with the process of the ecosystem. *Ecological design* involves the holistic consideration of the sustainable use of energy over the life-cycle

Table 2.6 Chart for assessment of ecological design(adapted from Yeang 1999, p.12).

Design Mode	Ecological
Build form configuration	Environment influenced
Building Orientation	Crucial
Facade and windows	Environment responsive
Energy source	Generated/ambient/local
Energy loss	Crucial/reused
Environmental control	Electro-mech/manual
	Artificial/natural
Comfort level	Variable/consistent
Low-energy response	Passive/electro-mech
Energy Consumption	Low energy
Materials source	Low environmental impact
Materials output	Reuse/recycle/reintegrate
Site Ecology	Crucial

of a building system. Building orientation and energy loss is crucial (Table 2.6). *Waste management* is an important design strategy to tackle with environmental problems.

Construction waste is important issue as a substantial proportion of landfill waste is debris from building and demolition. The strategies include waste use, building materials and consumption of natural resources including water; vegetation and soil. After completion of the building, it's not the building, but the occupants using it,

generate waste. The architect can facilitate recycling of domestic waste storage and collection of non-organic waste (ACE 1999, p.44).

2.A.2.5 Energy Conscious Design

Energy is defined by physicists as the capacity to do work, which is done when an object is moved against a force. *Energy* is found on this planet in a variety of forms, some of which are immediately usable by human societies to do work like fossil fuels, others require transformations. There two categories of energy sources which are renewable and non-renewable energies.

All conventional types of buildings are major energy consumers. On-site construction activity requires electricity for tools, lighting, hoists and other electrical items. Cranes and mixers use fossil fuels which cause atmospheric pollution. *Energy* use continues during the life-cycle conventional buildings for many purposes

Table 2.7 Chart for assessment of energy conscious design (adapted from Yeang 1999, p.12).

Design Mode	Energy Conscious
Build form configuration	Energy influenced
Building Orientation	Crucial
Facade and windows	Energy responsive
Energy source	Generated/ambient/local
Energy loss	Crucial/reused
Environmental control	Electro-mech/manual
	Artificial/natural
Comfort level	Variable/consistent
Low-energy response	Passive
Energy Consumption	Low energy
Materials source	Important
Materials output	Important
Site Ecology	Important

including heating, cooling, lighting, domestic hot water, and to operate various appliances. All these systems gives out heat and gases that contribute to the greenhouse effect. In hot weather, heat generated by lights, people and appliances

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causes air conditioning systems to be installed. This later addition of cooling system causes visual discomfort and additional cost to the building user.

Energy conscious design needs to adjust the energy consumption in the building with minimal effect on occupant's thermal and visual comfort. Materials source and input is important, but it is not crucial. Energy use is crucial for the design, so renewable energies should be introduced if energy is needed. *Energy conscious design* aims to use as much passive methods as possible.

Energy conservation is a matter of balancing heating and lighting needs and addressing energy use, energy controls and energy generation as related factors. A building consumes energy in a number of ways in the manufacture of building materials, components and systems in the distribution and transportation of building materials, components to the construction site; and in running the building and its occupants' equipment and appliances. A building also consumes energy in its maintenance, alteration and final disposal.

Embodied energy is the sum of resources required for creation, manufacture, construction, demolition and disposal of a building or component (Jones 1998, p.12). Grey energy is expended in transporting materials and components from places of extraction and manufacture to the construction site, can be minimised by support of local industries and the use of local materials. Where there are no suitable local resources available, careful account needs to be taken of delivery distances and the mode of the transport employed.

Induced energy, the energy used in the construction itself, is normally modest in comparison to embodied and grey energy, and for this reason is not usually given much attention. The architect should ensure, at tender stage, that the builder has a comprehensive energy policy for site operations, including waste avoidance (5 to 10 percent of building materials are thrown away unused), economic use of water and

eco-friendly disposal of demolished materials, and that this policy is acted upon during construction (Jones 1998, p.12).

Operation energy is the energy used in running a building. This kind of consumption will continue as long as the building stands and is occupied which could be more than hundred years (Jarmal 1992, p.36).

2.A.3 SOCIAL AND POLITICAL STRATEGIES ON ENVIRONMENTALLY RESPONSIVE DESIGN

Social and political strategies on *er design* in architecture, first began after the 1973 oil crisis and peaked rapidly following the 1992 Rio de Janeiro Earth Summit in Agenda 21. After the 1973 oil crisis, industrialised governments' political strategy for influencing *er design* in public aimed to create special funds for the academic institutions. These funds were spent to convince both the public and the professionals about the benefits of *er design*. Analysis tools, case studies, monitoring data and various design options were developed to encourage architects to implement these design principles in their projects[2]. Architects have been urged to take responsibility for a 'green ethic', due to the central role they play in influencing the environmental performance of the built environment (Mackenzie 1991, p.167).

Today, *er design* is developing rapidly in developed countries as a result of growing concerns over environment and energy related problems. Governments, academic institutions, industrial manufacturers, consultants and clients are becoming more aware of the benefits *er design* offer to the built environment.

The agreements reached at 1992 Rio de Janeiro Earth Summit Agenda 21, are put into use throughout the developed countries. The consequences of global climate change and ozone depletion could not be ignored by their governments. New laws and regulations are rapidly being established to encourage the use of environment and energy related strategies in buildings.

[2] http://www.ntua.gr/en_index.htm

Governments have a role in encouraging *er design* through regulation, legislation and funding *er design* schemes. Some governments began to undertake the monitoring of the performance of all new and refurbished buildings. For instance, the *Building Research Establishment Environmental Assessment Method (BREEAM)* assessment (Table 2.8) is one of the earliest environmental labelling scheme that assesses the environmental quality of buildings. It considers design issues that affect the global environment, local environment and the health and well being of building occupants. BREEAM was co-developed by ECD and the Building Research

Table 2.8 Objectives and benefits of BREEAM(http://www.ecde.demon.co.uk/breeam.htm).

OBJECTIVES OF BREEAM
1. To enable developers, designers and users to respond to a demand for buildings which are friendlier towards the environment.
2. Raise awareness of environmental issues which are affected by buildings,
3 To set targets and standards which are independendly assessed
4. Reduce the long term impact of buildings on the environment,
5. To reduce the use of scare resources such as water and fossil fuels,
6. To improve the quality of indoor environment.

BENEFITS OF BREEAM
1. Identification of business bottom line benefits. For every 1 Pound spent, the BREEAM process identifies up to 650 Pounds of operating cost savings.
2. Increade productivity through identification of Sick Building Syndrome, leaving to reduced absenteeism
3. Managers can reassure employees that their offices are healthy and high quality.
4. Improved sales for developers through credible communication of a buildings high environmental performance.
5. Designers are able to demonstrate their environmental achievements and low operating costs.
6. Landlords and occupants can cost-effectively and continuously audit thier property portfolio, set targets and gain verifiable targets.

Establishment (BRE), with the first version for offices being released in 1990. Since than, over 500 buildings have been assessed. A trained ECD assessor visits the building to carry out a survey. A report is prepared whether the building has addressed the issues of BREEAM. The report gives guidance on possible improvements which could be implemented before the BREEAM certificate is

issued. The *BREEAM* scheme is currently used in UK, Canada and Hong Kong to meet international obligations on carbon dioxide emissions.[3]

Building is one of the primary ways in which the natural environment could be changed by using resources far from the particular site involved. The types and quantities of energy and natural resources that go into the building's structure, their source and the environmental effects at the point of extraction all need to be considered (Yeang 1999, p.282).

Architects who are responsible for the creation of built structures should increase their knowledge of the interactions between architecture and surrounding environment. Architects' education begins at schools of architecture. These institutions have the goal of equipping their students with adequate knowledge to enable them to achieve successful outcomes from their designs. Courses on architecture could help motivate the students on environmental consciousness in design.

New laws have created the requirement of new design skills and alternative technologies. Professionals with new environmental sensibilities will find their services useful, while those blindly loyal to the outdated system will find themselves increasingly marginal. This represents a challenge for architectural education (Edwards 1999, p.269).

Schools of architecture which are aware of environmental sensibilities have re-structured their undergraduate programs. In some universities there are graduate programmes available for students who wish to receive further education on the field. For instance, in the Architectural Association's 1999 prospectus, a private school of architecture based in London, environment and energy programme was introduced to the students who desire to continue graduate education in the following text:

[3] http://www.ecde.demon.co.uk/breeam.htm

> The environment and energy programme is concerned with the theory and practice of sustainable, ecological design. The course combines training in environmental design research with field studies and real-life design projects. It seeks to improve communication and collaboration between the design disciplines, to develop critical faculties and design skills which are essential to the evolution of the architectural profession, to promote innovative design, and to eliminate the use of non-renewable energy sources. The complex and contradictory issues of sustainability are explored through the critical study of both theories and built examples, and the application of analytic tools and environmental assessment techniques (AA Prospectus 99, p.72).

Another role of the academic institutions is to develop the theories and the necessary data for the assemblage of design method. Their investigations will provide insight for practising architects. Academic institutions and architects should work closely together for the development of any design method. Especially in *er design* academic institutions' and architects' collaboration is essential. For instance, academic institutions could monitor the performance of buildings. Their reports could guide architects to achieve better environmental performance.

The master programme given at architecture department of METU university, provides opportunity for architects to write their thesis in an architectural field that they are interested in. Although, there is not a separate master programme entitled 'environment and energy', anyone who wants to study *er design* issues , could adjust his/her master study by choosing the elective courses useful in their thesis. They can work in collaboration with tutors who are experience on the *er design* field. For instance, Ayşem Berrin Zeytun's thesis, Sustainable Buildings and Building Materials(2000), focuses on *sustainable design and* materials that are sustainable and environmently friendly. Izzet Ozkeresteci wrote a thesis titled, Critical Evaluation of Architecture from the Ecological Perspective and Ecological Strategies for Architectural Design (1998). Izzet Ozkeresteci's thesis contributes structural analysis of ecological design with its strategies. Ergün Ozan's thesis called A Study on Job-Site Wastage of Building Materials in the Construction Industry of Turkey(1999), concentrates on building sites' waste management strategies. There are many other thesis on *er design* field, available at METU Library.

In addition to financial, legislative and client pressure, market pressure also plays a major role in encouraging changes in *industrial behaviour*. It is very much in the

interests of industry to follow the environmental debate closely and try to keep ahead of legislation at all times. Consideration of the environment brings about a major new market opportunity

Inventions of new materials and technologies help to solve design problems with environmental concerns. However, some of them cause environmental impairment. Some governments are forcing the manufacturing industry to produce ecological materials. The manufacturing industry began to produce materials with eco-label on them following the government regulations. However, the eco-labeling of building materials and products requires the use of studies such as life-cycle analysis, impact assessment, energy modelling to reach a full measure of the ecological impacts (Edwards 1999, p.209).

When environmental problems began to be felt forcefully in the 60s, it was believed that they were just technological problems that could eventually be solved by means of newer and more developed technologies. In other words, the technological and scientific method of problem-solving was thought to be enough to produce new solutions not only for environmental problems, but for all kinds of problems.

Newer technologies often tend to be less polluting and less dangerous than what they replace. However, any new developments in technology brings with it unknown problems. There does seem to be many opportunities for using sophisticated technology to improve environmental performance. Use of Internet and computers eliminate significant amount of paper consumption; fibre optics offer an opportunity to save on precious metal reserves; cash machines save time and resources on the construction of bank branches (Scott 1998, p.32).

Architects may find themselves identifying problems which must be addressed by technology. Sometimes, existing technologies may not be able to provide solutions, and the designer may have to stimulate and influence the development of a new technological approach. Architects must monitor the environmental agenda carefully, they should also follow technological developments, to be sure of incorporating the most e advanced technology (Mackenzie 1991, p.160).

2.A.4 DESIGN STRATEGIES FOR ENVIRONMENTALLY RESPONSIVE DESIGN

Design strategies on *er design* are influenced from *site conditions*, *building*, *operational systems*, and *life-cycle management*. Before constructing the building on site, architects should conduct necessary investigations to avoid building to cause degradation to the surrounding ecosystem. Design decisions that fail to consider *site conditions* consequently effect the local ecosystem.

Table 2.9 Environmentally responsive design strategies (by Eray Bozkurt).

DESIGN STRATEGIES FOR ENVIRONMENTALLY RESPONSIVE DESIGN			
SITE CONDITIONS	**BUILDING**	**OPERATIONAL SYSTEMS**	**LIFE-CYCLE MANAGEMENT**
Topography	Building Envelope	Passive Heating	Recycling
Orientation	Shading	Passive Cooling	Reuse
Vegetation	Indoor Air Quality	Active-Mode	Durability
Wildlife	Material Selection	Productive -mode	Waste
Wind	Thermal Mass	Lighting	Remanufacture
Sun		Water Conservation	Repair and Maintenance
Humidity			
Temperature			
Precipitation			

Another advantage of conducting investigation on site will provide energy savings for the buildings. Topography, orientation, wind, sun, temperature and humidity investigations provide necessary design decisions on passive methods. If the building's form and function responsive to site conditions, then the energy use and environmental degradation will be lowered as desired.

Operational systems depend on the building's form and function. Earlier decisions on passive operational systems on the building, will prevent the use of active systems which cause emission outputs and more energy use. After building's completion, if the building is depended on active systems, during it's life cycle, there will be continuous use of fossil fuel energy as a result produces harmful emissions.

Life-cycle management is important strategy for maintaining environmentally friendly built environment. Reuse and recycling of building components can help to reduce the use of precious global resources. During the life-cycle of the building, there should be a balance between inputs and outputs. The nature can easily digest the lowered emissions.

2.A.4.1 SITE CONDITIONS: Topography, Orientation, Vegetation, Wildlife, Wind, Sun, Shading, Humidity

Topographical features of the site can modify temperature, humidity and direction of the wind (Figure 2.4). They can provide protection for certain sites, but at the same time over-expose others. They can also modify the direction of the prevailing winds over considerable area. A flat valley, surrounded by mountains experience poor ventilation conditions, a high frequency of nightly temperature inversion and associated with air pollution. A narrow valley, facing the wind concentrates the airflow, especially the buildings in cold regions, may suffer from excessive wind speed. On the other hand, in warm-humid regions where natural ventilation is essential for thermal comfort, such windier locations may be the desirable ones (Givoni 1998, p.278).

The geometrical assessment has to take into account the three-dimensional nature and seasonal effect of the surrounding terrain. Obstructions to the south tend to cause most overshadowing in winter because of the sun's low altitude. Valleys running east west therefore face the risk of permanent overshadowing from the southerly slope in winter (Goulding 1993, p.31). Air in contact with surfaces warmed by solar radiation rises while air in contact with cold surfaces goes down. **Topographical** features can force the **precipitation** to flow towards the openings in the ground and create humid soil pockets. In sunny weather, the air above the pockets is cooler than the surrounding.

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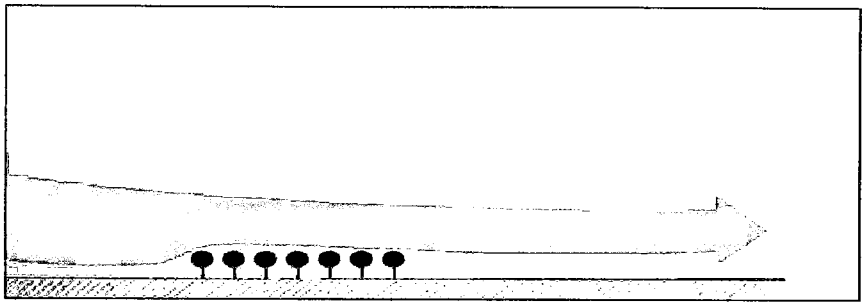
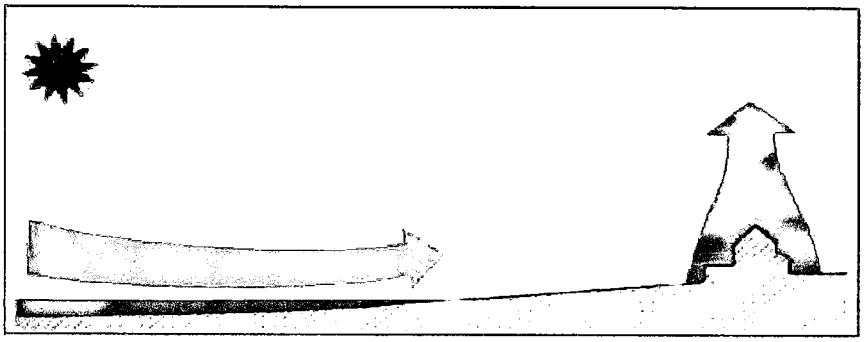
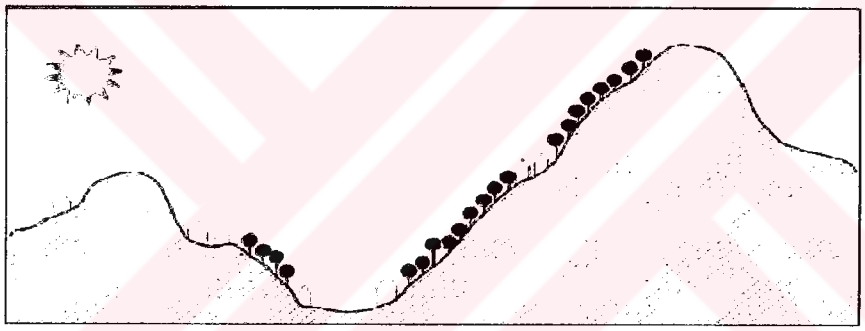


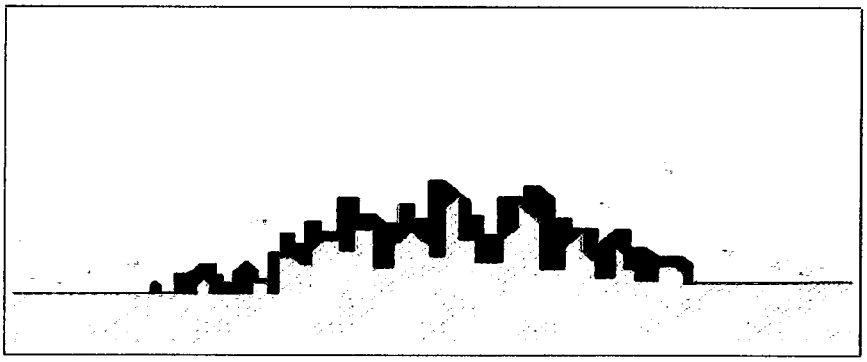
Flat Open Country



Coastal Regions



Mountain Regions



Cities

Figure 2.4 Topographical Features (Goulding 1992, p.37-39).

Part of the site development two primary environmental and energy considerations in the sitting of a building are **orientation** to the sun, and **orientation** to the wind (Jarmal 1980, p.41). When considering orientation to sun, architects should locate spaces requiring continuous heat on southern facades. Occupants can benefit from the solar gain, and reversibly architects should locate the places which don't need heat gain, in north side of the building. **Orientation** to the wind depends on the location of spaces. For natural ventilation the depth and section of the building are critical (Yeang1999, p.60).

Table 2.10 Chart showing number of species (Yeang 1999, p.100)

Group	Described species	Estimated species	Percentage of total already described
Micro-organisms			
Bacteria	3,000	2,500,000	0.1
Plants			
Algae	40,000	350,000	11
Bryophytes	17,000	25,000	68
Vascular plants	220,000	270,000	81
Funghi			
(including lichens)	69,000	1,500,000	5
Animals			
Nematodes	15,000	500,000	3
Arthropods	80,000	6,000,000	13
Fish	22,500	35,000	64
Birds	9,040	9,100	99
Mammals	4,000	4,020	> 99

Architect should consider the eco-system and climate conditions on the site by and preserving the natural conditions, and reduce the impact of design on the nature especially the existing **vegetation** (flora). For preserving flora conditions on site, sensitive local plant species need to be identified and protected. Existing flora should also be maintained to encourage *biodiversity* and to protect the nutrients held in the green canopy. **Flora** is significant because it protects wildlife habitats, nutrients, and soils; enhances visual beauty; offers acoustic and visual screening for privacy; provides a primary source of shade; and in some cases, creates opportunities for the production of food or other sustainable products (Yeang 1999, p.109). Table 2.10 shows the number of described and estimated species of plants.

The green spaces in a neighbourhood can moderate local microclimate. **Vegetation** modifies *humidity*, *air temperature*, *wind*, *sunshine*, *noise and air pollution* (ACE 1999, p.52). The **vegetation**'s effect of on **wind** conditions depend on the type. Areas with grass pose the least resistance to airflow and allow for the best possible ventilation conditions (Figure 2.5). Bushes block the wind near the ground surface and above them which is desirable in cold regions and seasons, but not in hot and hot-humid regions (Figure 2.5).

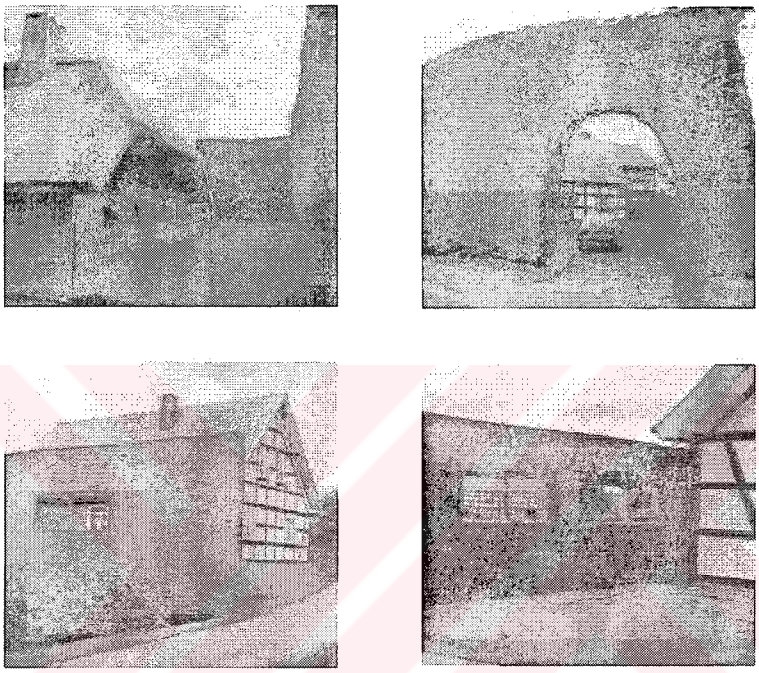


Figure 2.5 Methods of using vegetation (Goulding 94, p.96).

Plants can affect the indoor temperature and the cooling and heating loads of buildings. Trees with high canopy and pergolas near walls and windows, provide shade and reduce the solar heat gain. Dense plants near the building can lower the air temperature next to the skin of the building, reducing the conductive and infiltration heat gains. In winter, they help to adjust the desired solar gain. By reducing the wind speed around a building in winter, plants can minimise the infiltration rates and heating energy use. Ground cover by plants around a building reduces the reflected solar radiation toward the walls from the surrounding area, lowering the solar gain in summer (Givoni 1998, p.237).

The precautions need to be taken also for the existing **wildlife** (fauna) population. Sensitive wildlife habitat areas should be avoided for construction. Creating artificial habitats can have disruptive effects on the natural ecosystem. For instance, it has been calculated that 75 percent of the world's bird species are declining and nearly 25 percent of the 4,600 species of mammals are threatened with extinction (Yeang 1999, p.109). In Table 2.10 shows the number of described and estimated species of fauna.

Winds or air movement in the earth's atmosphere is caused by pressure differences generated by complex climatic factors. Deep valleys or long straight avenues can funnel and accelerate wind speeds. High building can create localised high wind speed and turbulence (ACE 1999, p.55). During the design process, architects should design to avoid excessive **wind** speeds and turbulence in natural areas (Figure 2.6). Ground shaping, planting, windbreaks or structures near the building can guide harmful and uncomfortable winds. Architects can also influence the **wind** speed around a building through its form (Figure 2.7).

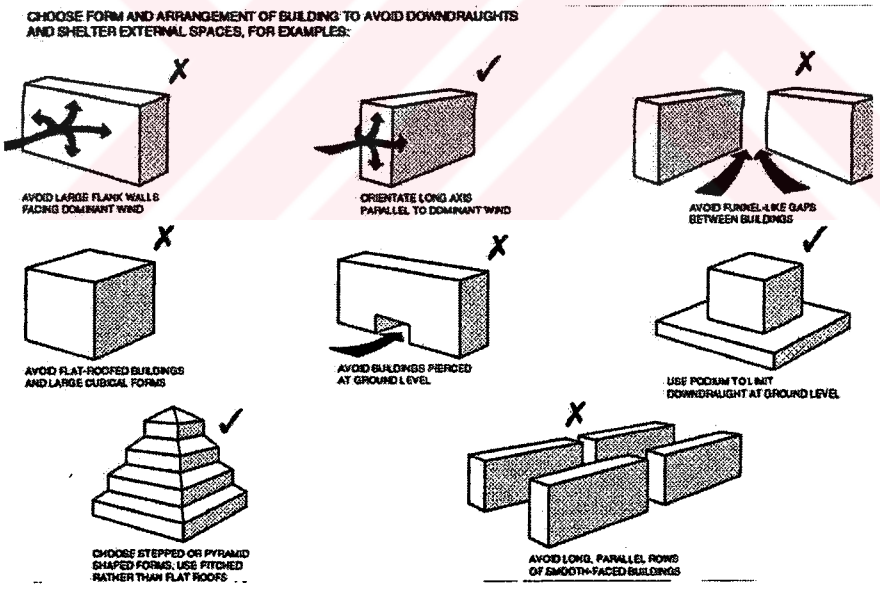


Figure 2.6 Building form configuration strategies for wind conditions(Goulding 1992, p.45).

Architects should obtain mean daily **wind** speeds and direction chart for the region from meteorological station. Maps of wind roses which give information of wind speeds are included for four critical months. For temperate climate, the coldest will be January, the hottest will be July and two transition months will be April and October.

The position of the sun in the sky and the direction of the solar beam are described by the solar altitude and solar azimuth angles. The altitude and azimuth angles vary from hour to hour and season to season. The solar altitude and azimuth for the whole year can be plotted on a solar chart (Goulding 1992, p.19). Having the solar chart of the site will help to develop the designs on daylight, heat gain and visual comfort in the next design stage (Figure 2.7).

Humidity varies considerably, tend to be highest close to lower areas when air temperature is lowest, and decreases as the air temperature rises. In winter, monthly mean daily temperatures are very high in Western Europe. They have a tendency to increase as one proceeds towards the Atlantic Coast. In summer, they are lower, but still quite high due the Atlantic coast influence. They fall with dry winds from the Polar Regions and the dessert areas at the south of the Mediterranean. In areas with high **humidity** levels, transmission of solar radiation is reduced because it's absorbed by water vapour and absorbed by clouds. Very dry air on the other hand, causes hot days and cold nights.

2.A.4.2 BUILDING: Building Envelope, Shading, Indoor Air, Quality, Material Selection, Thermal Mass

Design team can research on the projects with efficient performance of environmental issues. In *er design*, the link between building performance and the design of the **building envelope** is critical. A better **envelope** may sometimes be more expensive to build, but it improves the balance between heat gain and heat loss, reduces the size of conventional heating system (ACE 1999, p.63). Building

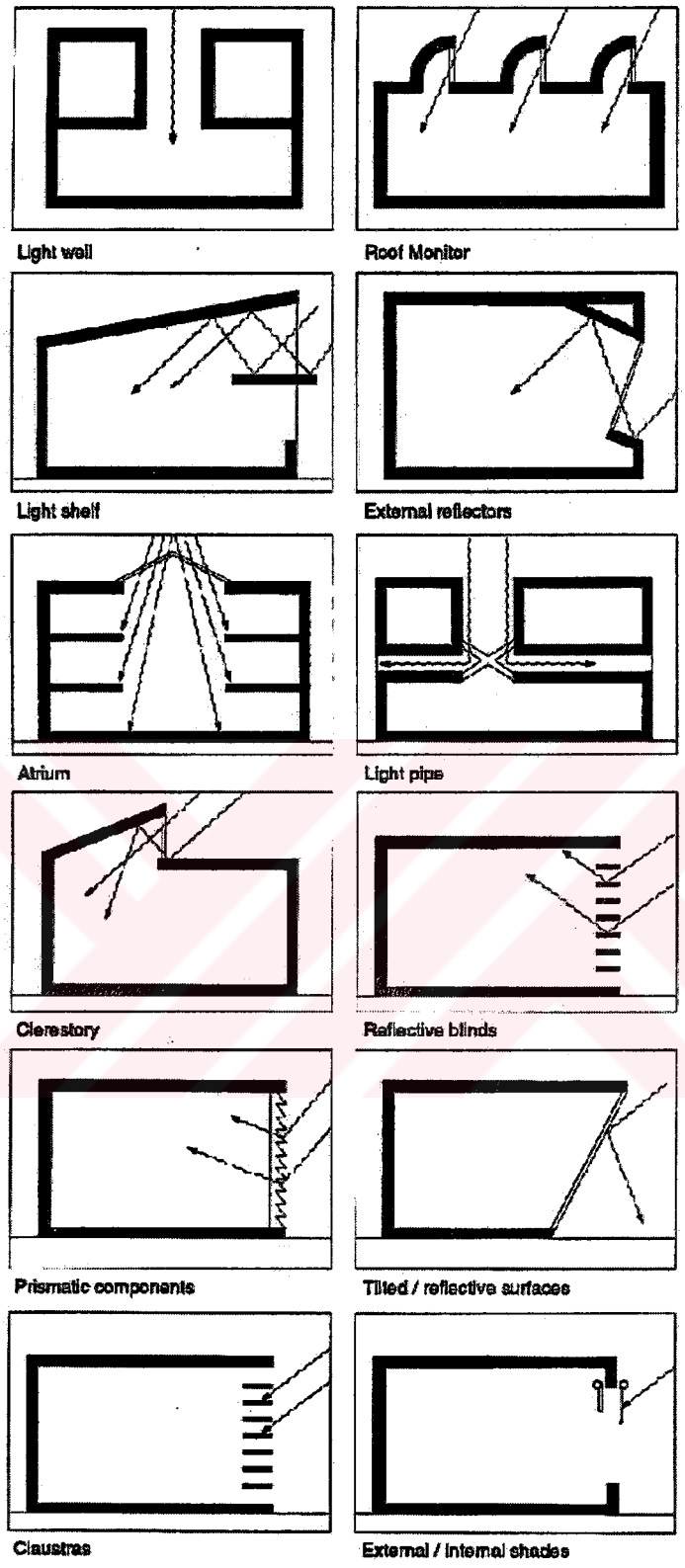


Figure 2.7 Methods for control of sunlight

envelopes need to be durable, aesthetically pleasing, weather tight, structurally sound and secure. Building envelopes need to respond solar radiation both for the sun's heat and light, design systems to be introduced to allow natural ventilation with minimised heat loss, noise and dust (Thomson 1996, p.40).

Shading is needed to control overheating in the summer. **Shading** control at the building envelope must be related to the activities in the building, its mass and ventilation system. A historical example, illustrating the need for shading devices, is Le Corbusier's Salvation Army Hotel in Paris. The original design included a way of removing heat from in front of an inner skin of unopenable south-facing glazing. However, for the cost reasons the design was altered leaving only the fixed glazing which almost roasted the occupants. Later, sun screen was added to reduce overheating (Thomas 1996, p.42).

Fixed shading systems (Figure 2.8) include structural elements such as balconies, non-structural elements such as canopies, blinds, louvres and screens. Fixed shading systems are used mainly on the external facades where they can prevent direct radiation from reaching glazing and where heat observed by the shading system can be dissipated to the outside air (Goulding 1994, p.100).

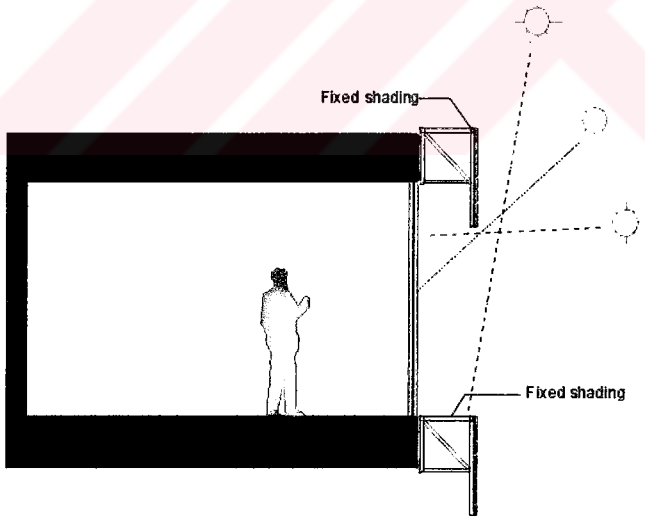


Figure 2.8 Example for fixed shading (Eray Bozkurt)

Movable shading systems (Figure 2.9) are used externally or internally. Control can be either manual or power assisted and may be automated to respond to changing conditions such as current radiation levels and daylighting or thermal requirements. Reflectant blinds, curtains and blinds fitted internally less satisfactory as they provide shade only after the solar radiation pass through glazing.

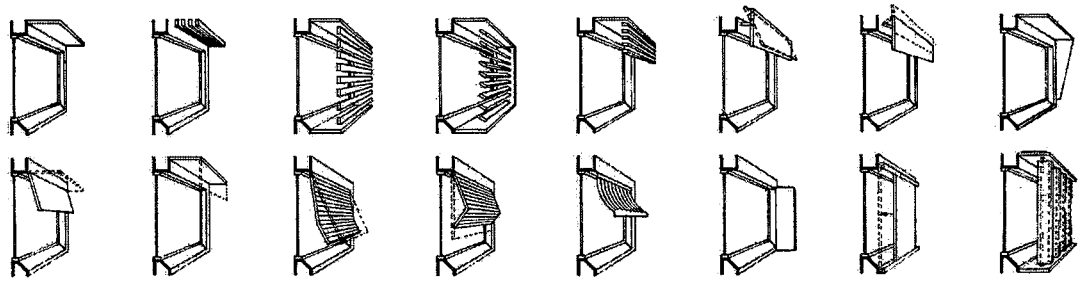


Figure 2.9 Typical external shading devices (Goulding 1994, p.97).

Indoor air quality is important to human health and well being, since a great deal of time is spent indoors, at work, home, or school. Unhealthy buildings contain volatile organic compounds which can be found in paint, carpet, fabric, cabinets, etc (Figure 2.10). The smell of newly constructed places is often actually toxic outgasing that is detrimental to the human health (Jones 1999, p.42). The effects of unhealthy buildings cause illnesses ranging from headaches, sinus and lung irritation to long term damage to the immune system. There are products available with reduced levels of volatile organic compounds that can be chosen to improve indoor air quality (Edwards 1996, p.172).

The term *sick building syndrome* is defined to describe the condition where people became ill from the inside environment because of poor thermal visual and aural comfort conditions, the gaseous pollutants, dust and fibres and tobacco smoke. In addition, external pollutants like traffic fumes, radon and landfill gases can affect the quality of the inside environment. Symptoms are headache, nausea, stress, sore throats, asthma attacks and similar illnesses. These can effect the performance of

the individual while working. The functions that cause the sick building syndrome are air conditioning, sealed windows, recirculated air, high-density occupation, smoking, air borne micro organisms, dust and dust-mite excrement (Edwards 1999, p.174).

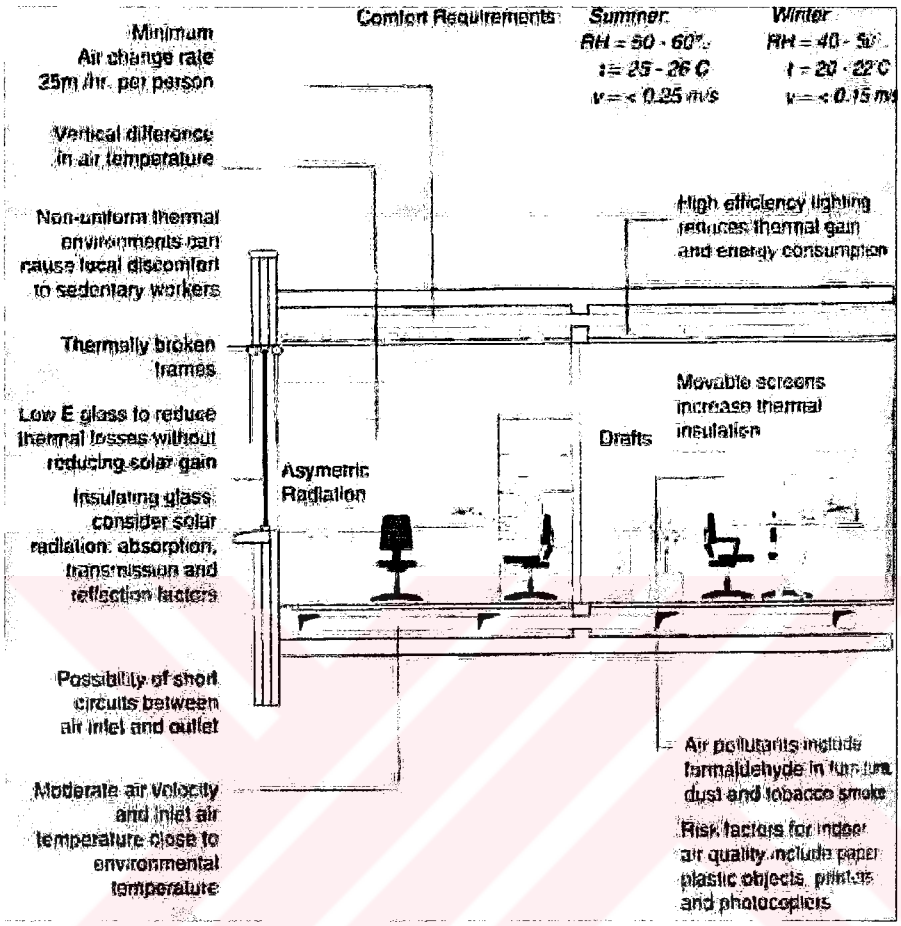


Figure 2.10 Thermal Comfort and Indoor Air Quality (ACE 1999, p.30).

Plants can absorb the toxins, formaldehyde, benzol, and trichloroethylene. Certain plants are well suited to elimination of contaminants (Figure 2.11). For example, an ivy plant is able to eliminate 90 percent of the benzol contained in and released through tobacco smoke, artificial fibres, dyes and plastics. Aloe, bananas, spider plants and philodendron are effective agents against formaldehyde which may seep from insulating foam and particleboard. Trichloroethylene from lacquers and glues is best eliminated with the help of chrysanthemums and gerbera (Yeang 1999, p.250).

With regard to humidification, plants are better agents than electrically powered air humidifiers or even humidifiers combined with air-conditioning systems because they don't provide favourable breeding ground for bacteria.

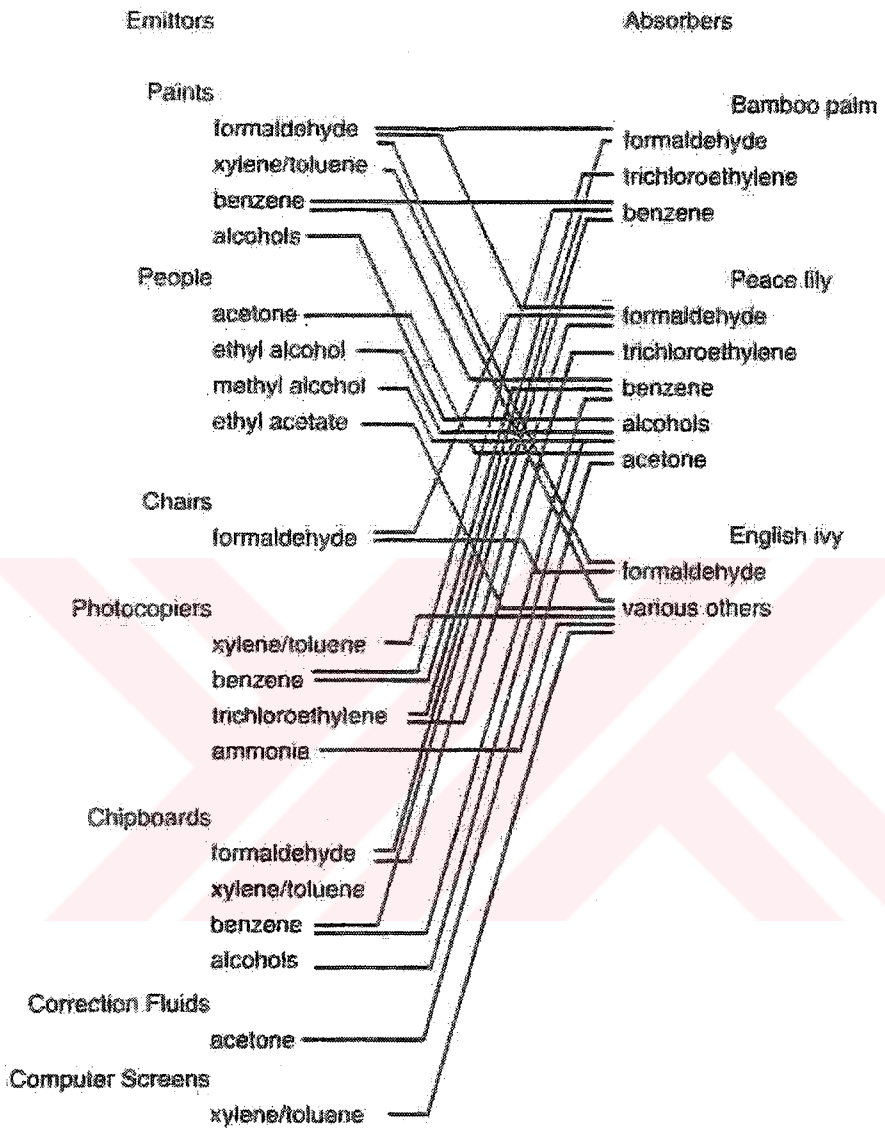


Figure 2.11 Plant use for healthy environment (Yeang 1999, p.250)

The conventional type of buildings ignore the health and visual comfort of its' occupants. Dean Hawkes in his book Environmental Tradition(1996), summarised the attitudes towards the occupants' needs:

> Until quite recently the theory and practice of environmental control in buildings did not take into account the nature of voluntary responses of building occupants to the environmental conditions they experience. To some degree this neglect was a reflection of the complexity of the subject, but was also a consequence of the predominant view of the aims and methods of environmental control, The desired environment is specified as a series of precise statements about temperature, ventilation rate, illumination levels and so forth. These are maintained within quite narrow limits and this usually means, in practice, that reliance is placed upon mechanical systems which are, in turn, subjected to automatic control (Hawkes,1996, p.29).

Designing with passive systems will improve the indoor air quality performance of the building. The choice of materials and efficient ventilation can provide desired conditions inside the building.

During **material selection**, architects have an opportunity to reduce the environmental impact and indoor air quality. They should be aware of which materials have hazardous products in them before making the final decision (Table 2.11). The carcinogenic effect of asbestos has led to its removal from many buildings. The use of lead in paints is being reduced or abandoned because of dangers it can cause to children if digested. Many of the modern products that contain formaldehyde, epoxy and acrylic resin and fungicides, are criticised not just for the pollution caused by their manufacture, but also because of concern that they can act as allergens, causing illnesses such as asthma, hay fever and skin problem. The use of chipboard made from waste materials offer many benefits, but the glues in the manufacturing process can be toxic in production and use. CFC's are used in insulating materials polyurethane and extruded polystyrene foam. They are also used as refrigerants in air-conditioning systems and in fire protection equipment. The selection of key materials and components will depend on a wide variety of factors. Noise transmission, structural spans, fire considerations and cost are just a few of the constraints that guide the building process. The design information needs to be examined carefully.

Table 2.11 Materials and their contents (Yeang 1999, p.140).

TRI Chemical	Potential health effects[a]	Sample products
Acetaldehyde	A, C, E[b]	Adhesives
Acetone	Ch, E	Varnishes, lacquers, paint thinners, furniture strippers, adhesives, nail polish remover, art supplies, metal polish
Acrylonitrile	A, C, D, E, R	Fabric, apparel
Ammonia	A, Ch, E	All-purpose cleaners, glass cleaners, hair dyes
1,3-Butadiene	C, Ch, D, R	Carpets
Carbaryl	A, Ch, E, N, R	Pesticides, pet flea and tick treatment
Cadmium	A, C, Ch, D, E, R	Nickel/cadmium batteries
Chlorine	A, Ch, E	Chlorine bleach, disinfectants
Chlorothalonil	C, E	Lawn chemicals
Cresol	A, Ch, E	Art supplies, disinfectants
2,4-D	A, C, D, E, R	Lawn chemicals
Dibutyl phthalate	Ch, D, E, R	Paint, adhesives
1,2-Dichlorobenzene	E	Carpets
Di(2-ethylhexyl) phthalate (DEHP)	C, Ch, D, E, M, R	Plicate plastics, fabrics, apparel, hair spray
Diethyl phthalate	A, E	Paint, adhesives
2-Ethoxyethanol	Ch, D, R	Polyurethane, wood finish
Ethylbenzene	Ch, D, E, R	Carpets, paint
Ethylene glycol	Ch	Deodorants/antiperspirants, paints
Formaldehyde	C, Ch, E, M, R	Plywood, particleboard, clothing, adhesives, upholstery, fabric, fingernail polish
Hydrochloric acid	A, Ch	Toilet cleaners
Lead	D, N, R	Batteries, stain/varnish/sealant, hair dyes
Mercury	Ch, E, N, R	Batteries
Methanol	N	Paint thinner, strippers, adhesives
Methylene chloride (dichlorome thane)	C	Spray paint, rust paints, paint strippers, adhesives, adhesive removers, pesticides
Methyl ethyl ketone	Ch, D, N, R	Paint thinner, adhesives, cleaners, waxes
Methyl isobutyl ketone	Ch, N	Paint thinner, pesticides
Naphthalene	E	Mothballs, adhesives, pesticides
Nickel	C, Ch, D, R	Batteries
n-Butyl alcohol (*n*-butanol)	Ch	Paint strippers, perfume, aftershave lotion
Paradichlorobenzene (*p*-dichlorobenzene)	C, Ch, E	Mothballs/crystals, certain air fresheners, toilet deodorizers
Pentachlorophenol	A, D, E, R	Varnish/stain/sealant
Perchloroethylene (tetrachloroethylene)	C, Ch, D, E, R	Dry cleaning, rug/upholstery cleaners, spot removers
Phenol	A, D, E	Art supplies, adhesives
Phosphoric acid	None listed	Metal polish
Styrene	C, Ch, E, M	Carpets, building materials
Sulphurcic acid	A. Ch, E	Batteries
Toluene	D, E, M, R	Paint, nail polish, furniture strippers, adhesives, art supplies, carpets, paint strippers and thinners
1,1,1-Trichloroethane (methyl chloroform)	D, E, R	Carpets, dry cleaning, spot removers, fabrics, typewriter correction fluid, adhesives/glues
Vinyl chloride	C, Ch, D, M, R	A variety of household plastics, including furnishings and apparel
Xylenes	Ch, D, E, R	Paints, adhesives, pesticides, art supplies, furniture strippers
Zinc	E	Batteries

(Source: INFORM, Inc., 'Tackling Toxics in Everyday Products: A Directory of Organizations' (New York, 1992))
Note:
a. Health effects data are from the U.S. Environmental Protection Agency's (EPA's) toxicity matrix for right-to-know chemicals. The assembled information is presumed to be incomplete; further testing would be likely to produce additional entries on the matrix. For information on chemical synonyms (omitted here) get the EPA's "Common Synonyms" publication.
b. Key to abbreviations: A – acute toxin, C – carcinogen, Ch – chronic toxin, D – developmental effects, E – environmental toxin, M – mutagen, N – neurotoxin, R – reproductive effects.

In buildings, **thermal mass** will absorb heat during the day and release it at night, reducing peak daytime air temperatures. The amount and distribution of thermal mass should be designed to store heating or cooling energy for most efficient use. **Thermal mass** can moderate the temperature of occupied spaces during conditioned periods and thereby minimise or eliminate the need for mechanical cooling (Edwards 1997, p.56). Wall materials can be categorised in terms of low or high **thermal mass**. For instance, masonry construction has good thermal inertia qualities which slow down the building's response to changes in external conditions and limit internal temperature swings. Clay bricks, concrete blocks and rammed earth are examples of this kind of construction (ACE 1999, p.64).

2.A.4.3 OPERATIONAL SYSTEMS AND SERVICES: Passive Heating, Active-Mode, Productive-Mode, Water Conservation, and Lighting

Operational systems and *services* provide thermal and visual comfort to occupant. After collecting information about site conditions and deciding on type of building, architects need to decide on what type of operational systems and services should be used. **Passive methods** mean operational system without the use of any electrical or mechanical system. **Active systems** or conventional systems means energy dependent or partially assisted electrical and mechanical systems. For passive methods to be effective, building's orientation to *sun* and *wind* plays the active role. Sun is more effective at south direction, persuades architects to locate spaces which need more natural light and heating. However, solar energy needs to be controlled with shading devices to adjust the unwanted solar radiation and light. Even this simple combination of passive systems will help to minimise the use of *active systems* use in the building.

The majority of energy use and a similar proportion of carbon dioxide emissions are associated with buildings, with 60 percent attributed to the residential building type and 7 percent to the commercial office building. Architects need to consider passive systems as first priority for operational system. If desired conditions in the building could not be achieved then consider active systems.

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

Design strategies for **operational systems**:

- **Passive systems** of energy use and recycling. These systems should be preferred over active systems. Architects should explain the client the possibilities of passive measures and their contribution to performance for *heating system. Passive heating* based on the climatic conditions of the site. It should exclude any electrical and mechanical devices.
- **Active operational systems**. They should have low energy and low environmental impacts.
- **Productive systems**, being systems that generate on-site energy. For instance, photovoltaics panels can be placed on the facade of the buildings to generate clean energy.

Design strategies for **passive heating,**

- *Solar collection* which solar energy is collected and converted into heat. Heat storage; the solar energy collected during sunny periods and stored for future use.
- *Heat distribution*; collected heat is distributed to the parts of the building which require heating.

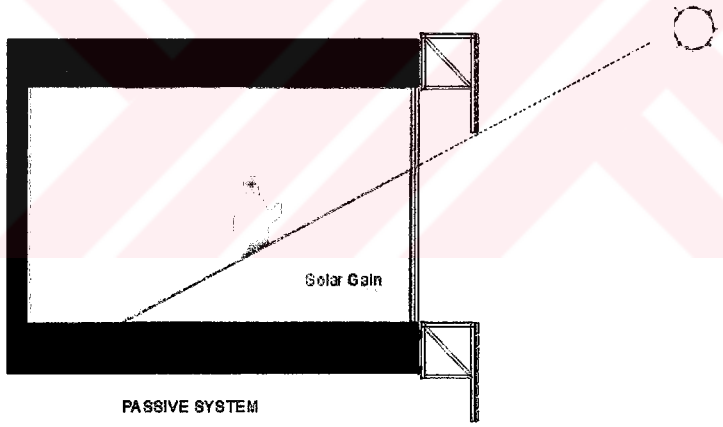


Figure 2.12 Passive heating (by Eray Bozkurt)

- *Heat conservation*; heat is retained in the building for as long as possible, as is any heat generated in the conventional heating system (Gouldling 1992, p.49). With these methods the amount of fossil fuels used will be minimised (Figure 2.12).

For cooling, the architect can achieve the comfort level inside the building by using **passive cooling. Passive cooling** applies to various simple cooling techniques which enable the indoor temperature of the buildings to be lowered through the use of fossil fuel energy sources (Givoni 1994, p.45).

Design strategies for **passive cooling**,

- *Solar control*; to prevent the sun's rays from reaching and entering the building.
- *External gains*; to prevent increases in heat due to conduction through the building skin or by the infiltration of external hot air.
- *Internal gains* to prevent unwanted heat from occupants and equipment raising the internal temperatures.

- *Ventilation*; unwanted hot air may be expelled and replaced by fresh external air at a suitable temperature. Good ventilation will reduce the risk to human health of emissions of toxic chemicals from furniture, construction materials and paints (Goulding 1992,90).
- *Natural cooling*; internal air speeds can be increased to maximise perceived cooling. Air adjacent to the building can be cooled by evaporation.
- *Radiant cooling*, transferring into the building cold energy generated during the night hours by radiant heat loss from the roof, or using a special radiator on the roof, with or without cold storage for daytime (Yeang 1999, p.258).
- Increasing the building's contact with the ground can provide additional cooling (Figure 2.14). Underground structures provide various advantages, protection from noise, dust and solar radiation. One example project for *ground cooling* is the Holy Island Buddhist Retreat Project by Andrew Right. The living areas of the Buddhist are earth sheltered. However, when using *ground cooling,* architects need consider strategies to prevent future problems like damp penetration, condensation and daylight (Goulding ,1994, p.95).

If the **passive heating** and **passive cooling** can not perform enough desired conditions in the building, then use of **active systems** are unavoidable.

Design strategies for **active operational systems** are:

- Avoiding dual-duct systems or fixed-volume terminal reheating, as both involve cooling air and reheating it as required at the point of use (Yeang 1999, p.267).

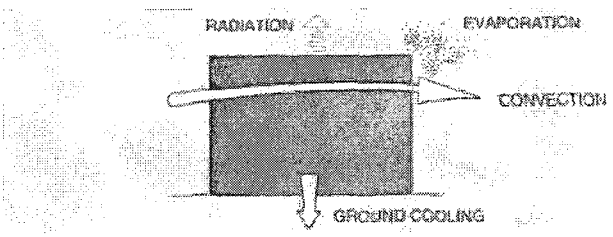


Figure 2.13. Passive Cooling Methods

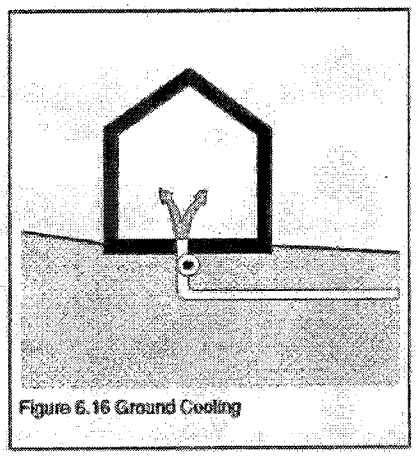


Figure 2.14. Ground Cooling

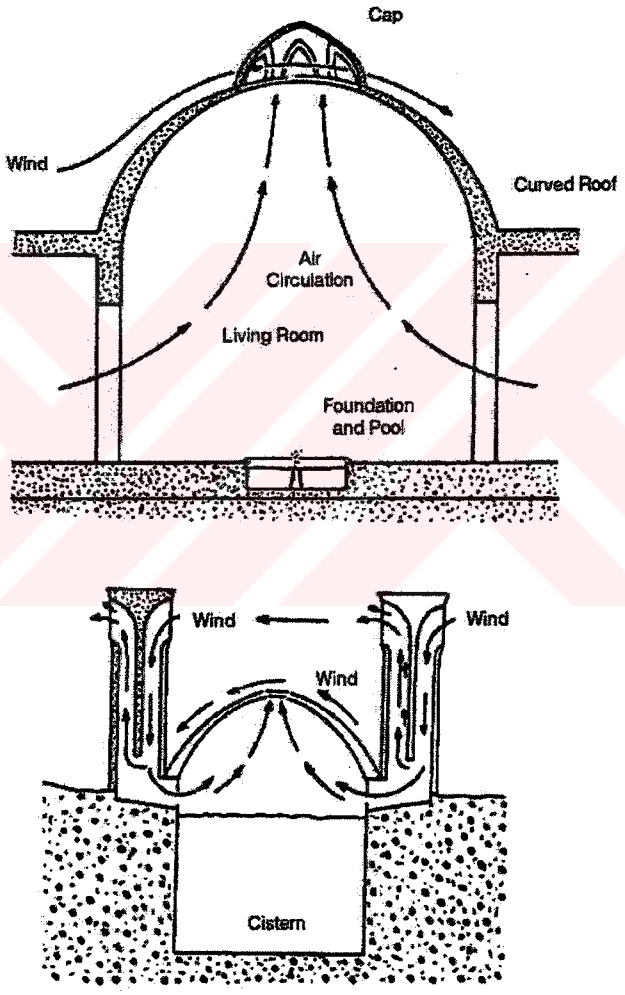
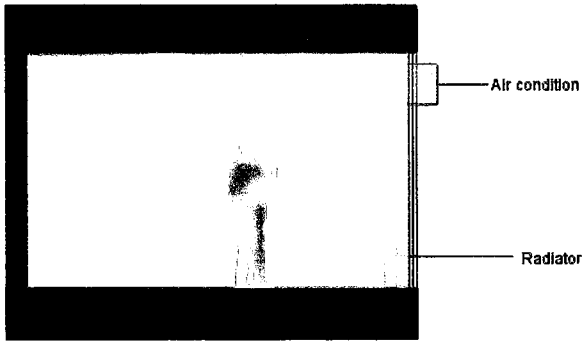


Figure 2.15. Ancient examples for Evaporative Cooling

- Avoid high-velocity systems as they consume more energy, but use less material (Yeang 1999, p.267).
- Employ heat reclaimed from parts of the building with a heat surplus (Yeang 1999, p.267).
- Avoid any system incorporating CFCs and HCFCs (Yeang 1999, p.267).
- Select equipment having maximum efficiency (Yeang 1999, p.267).



ACTIVE SYSTEMS

Figure 2.16 Active Systems (by Eray Bozkurt).

Er design should respect water resources. Population increases in urban centres, notably in developing countries, are exerting pressure on groundwater resources. Untreated human wastes remain the biggest pollution threat to water resource.

Water conservation strategies are:

- In kitchen and laundry areas, commercial appliances should be specified as water-saving models (Yeang 1999, p.267) .
- Low-flush toilets (Yeang 1999, p.267) .
- Collecting rainwater to reduce the need for treated water(Yeang 1999, p.268).

Productive modes are locally-generated energy resources such as photovoltaics which provide a clean, quiet and pollution-free energy source (Yeang 1999, p.272). Instead of imported energy, the building generates energy by placing solar cells on the facade.[4] The extra energy can be sold to the electricity company.

[4] See Appendix K.

Solar cells are generally expensive and of low efficiency, although current prices are falling and make their use more legitimate economically. Efficiencies are also improving.

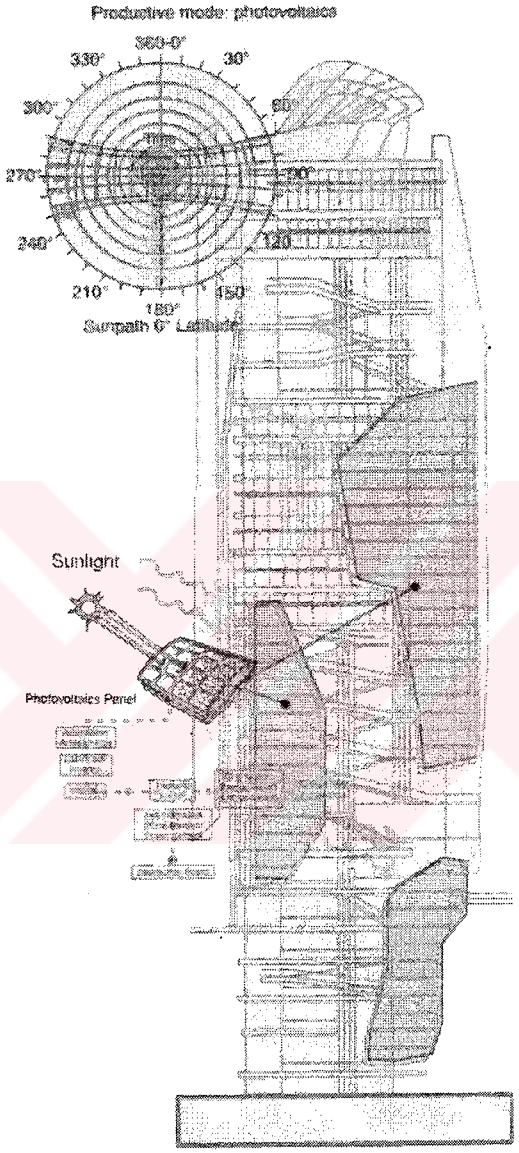


Figure 2.17 Use of building integrated photovoltaics (Yeang 1999, p.274)

Artificial lighting is a significant energy consumer in non-domestic buildings like offices, factories and schools. The provision of daylight in a building is strongly linked to the spatial and architectural design. The amount of energy consumed in lighting depends on the power consumption of lighting equipment and the time for which it is switched on. The optimum use of **daylighting** can reduce the amount of artificial lighting use (ACE 1999, p.86).

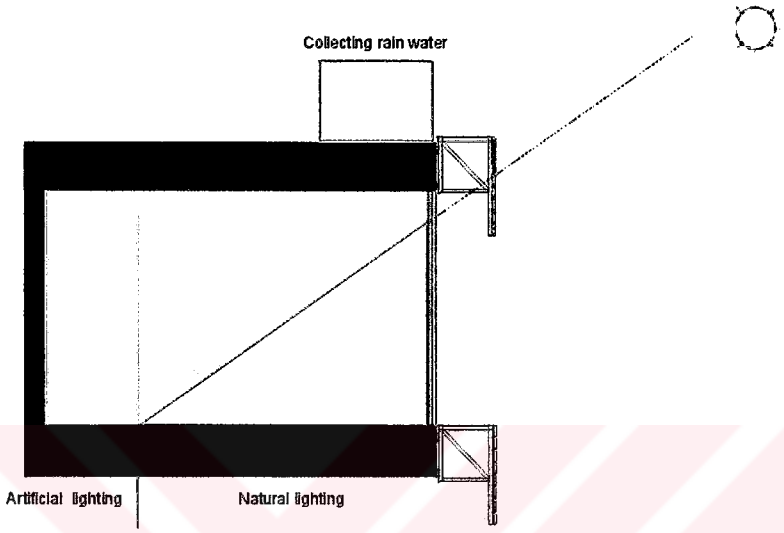


Figure 2.18 Lighting Strategy (by Eray Bozkurt)

Whether **daylighting** is used to meet lighting conditions or **artificial lighting** within the daylight lit zone, there is a decrease in illumination as one move away from the opening (Figure 2.18). As sky conditions change and less light available, and conditions in the farthest areas from the windows become darker. **Artificial lighting** should be planned considering this problem. The lighting can be controlled by a photosensitive cell so that it is automatically switched on or off when daylighting reaches certain level (Brown 1985, p.151).

2.A.4.4 LIFE CYCLE MANAGEMENT: Recycling, Reuse, Durability, Waste, Remanufacture, Repair and Maintenance

Recycling is the process of reprocessing materials. The benefit of recycling is to lower demand for raw materials and energy required in the manufacturing process

and reduction of waste to landfill. **Recycling** is a process that help to solve environmental problems. It can save some finite natural resources, in particular non-renewable sources like iron ore and bauxite ore that are used to manufacture steel and aluminium cans. **Recycled** materials are becoming supplementary materials in the manufacturing process to ease off the ever increasing demand for natural raw materials and energy consumption. To justify the **recycling** of a material, the architects should assure that the energy and resources saved are greater than those needed to make a new product. For instance, composite materials make recycling difficult.

Materials that can be **recycled** are aluminium, concrete aggregates, plastics, steel, stone and timber. Strategies for **recycling** (Yeang 1999, p.171):

- Making the components easy to disassemble for instance using mechanical methods of fixing (Yeang 1999, p.171).
- Reduce the number of different types of materials used.
- Avoid using combinations of materials that are not mutually compatible.
- Considering how materials can be identified.
- Ensuring that it is possible to remove easily any components which would contaminate the recycling process.

A long-life product which is easy to **reuse** or to **repair** means less overall waste. Designing products which last longer than their predecessors is one way to reduce waste through reuse. Sometimes this can be done by employing a new technology, as in energy-efficient compact fluorescent light bulbs, which last much longer than traditional incandescent bulbs. Another approach is to fabricate products using more **durable** materials (Yeang 1999, p.170). Materials that can be used are ceramics, glass, lighting fixtures, and steel.

Minimising **waste** will require skilful knowledge of the life cycle of the product and enough information about the performance of different materials within the **reuse** or **recycling** chain (Yeang 1999, p.171). It also raises fundamental questions about the wisdom of designing products that have a life expectancy far shorter than that of the materials of which they are made (Yeang 1999, p.171).

Remanufacture involves partial or total reconstitution of the output into its original form prior to use. This concept is sometimes referred to as 'products-in-service', where the supplier of the product or material will buy back the material after its use for remanufacture (Yeang 1999, p.171).

Strategies for **remanufacture** involves (Yeang 1999, p.172):

- Ensuring that parts are interchangeable between items (p.172).
- Making components repairable or easily replaced (p.172).
- Allowing for technological components to be replaced without affecting the overall frame of the product (p.172).
- Choosing a design aesthetic that allows for the easy update of that part of the building through the replacement of key components such as panels (p.172).

B- ENVIRONMENTALLY RESPONSIVE DESIGN IN PROJECT STAGES

Programming is the process of defining environmental problems and suggesting to the designer strategies for solving those problems. It is an activity that precedes environmental design and provides the designer with the functional, technical, and behavioural requirements of design. It is defined as an additional service to be rendered over and above the standard design activities. It is listed among such technical services as site investigations, feasibility studies, and engineering analysis and is intended to provide definitions of the owner's needs and to determine the requirements of a design project.

In any architectural project, organisation is crucial for efficient progress of the building. For continuous consciousness on *er design*, there is a need for mutual attitude. As every architect is familiar with the project stages of designs, this can be a starting point to maintain mutual attitude between architects. When the project arranged into stages, it can be a challenge for architects to control their buildings' environmental performance in each stage.

At the time of writing of the book A Green Vitruvius, sponsored by the European Commission and Architect's Council of Europe (ACE), the twenty or so architects in the Architect's Council of Europe (ACE) had more than a dozen documents describing the design and construction process for a building in their countries of origin. All these are compiled together to form the 1994 ACE Breakdown which divides traditional project stages into four main categories (Table 2.11). **Inception stage** organises the architect's agreements with their clients and consultants. **Design stage** is architects' own decisions in their offices in **preliminary studies**, **sketch studies**, **pre-project** and **basic project**. In **construction stage**, the contractors are responsible to put architects' design into physical reality without any changes. The architects responsibility at this stage to control contractors work.

Table 2.12 Project stages (by Eray Bozkurt).

PROJECT STAGES			
INCEPTION STAGE	**DESIGN STAGE**	**CONSTRUCTION STAGE**	**REFURBISHMENT STAGE**
Client and Architect	Preliminary studies	Operation and Maintenance	
Consultant and Architect	Sketch studies		
Briefing	Pre-project		
	Basic project		
	Execution of project		
	Tender procedure		

Refurbishment stage is done during the life cycle of the building. Some materials or components aren't long life like the structure of the building. For building to continue its' environmental performance they need to be replaced with new ones.

Various reference books are used to examine the project stages in *er design*. The main framework for the research is adapted from the book named A Green Vitruvius. It's aimed to form a mutual attitude between architects in the progress of their designs.

2.B.1 Inception

In Kenneth Frampton's article in Architectural Review's November 1999 issue, he gave seven points for the new millennium, especially on *er design*. Same article was part of the manifesto in **20th UIA Congress of Beijing**. He underlined the importance of clients attitude on environmental problems.

> It's well known that the intention of the client is absolutely seminal to the successful outcome of any architectural endeavour and that without a sensitive intelligent and responsive client, the aspirational range of a project becomes limited. To cultivate an adequate client base, the education of society in environmental design matters should be given the highest priority, beginning at high-school level, as many have advocated over the past 20 years.
>
> Unfortunately, we have yet to see a society willing to educate its children with regard to environmental ends as well as to the apparent benefit of ever-expanding economic means.'[5]

If clients have enough knowledge about environmental problems, and the benefits of designing response to environment, then they will be the one who will demand *er design* from their architects. At the end of the day, they are the ones who finance the projects and their attitudes are important for the development of the design. When this consciousness maintained between **clients and architects**, it will pass on rapidly to other fields as well.

Er design tasks can be identified in the **client-architect** contract:
In *preliminary studies*,

- Advising on environmental and life cycle cost (ACE 1999, p.9). Data on current energy consumption by buildings similar in scope which will provide energy budgets (Jarmal 1980, p.22).
- Making topographical models to study shelter, shading, orientation (ACE 1999, p.9).
- Analysing site *microclimate* (p.9). Vegetation, wildlife, wind, sun, humidity, temperature and precipitation.

[5] Kenneth Frampton. 'Seven Points for the Millennium'. Architectural Review, Nov.99, p.39.

In *sketch studies and pre-project*,

- Calculations of environmental performance objectives for heating and cooling (ACE 1999, p.9).
- Special research on sustainable systems, materials and components (p.9).
- Studying alternative methods of complying with building regulations, particularly with regard to thermal insulation, heating, cooling and ventilation standards, water supply and consumption and waste disposal treatment (p.9).

In *basic project*,

- Studies of room interiors to optimise daylighting and minimise glare (ACE 1999, p.9).
- Redesign work and detail studies of building facades to optimise energy performance (p.9).

In t*ender procedure*,

- Pre-qualifying contractors in relation to special requirements (ACE 1999, p.9).
- Checking to avoid uncompetitive loading of tenders (p.9).
- Preparing advice to contractors on site protection (p.9).

In *acceptance, defects period and maintenance*,

- Preparing special manuals with life cycle costing advice (ACE 1999, p.9).
- Advising clients on the use of passive and active environmental features in the building.

In *refurbishment*,

- Making comparative life cycle cost analyses of new build as against refurbishment costs (ACE 1999, p.9).
- Environmentally auditing of existing buildings (p.9).

The choice of **consultants** is important, especially at the outset of the project. They should be competent, firstly to understand the issues involved and secondly to give the architect best advice. The goal of the design process is to achieve optimum passive environmental system performance. The performance is to be considered over the project life cycle, through design, use and decomposing (ACE 1999, p.10).

Consultants should first advice on the *passive environmental control systems.* before *conventional systems.* In each four project stages, consultants should work in collaboration with architects (ACE 1999, p.10):

Building structure,

- Re-use of demolition spoil and use of existing materials on the site (ACE 1999, p.10).
- Embodied energy, use of pre-fabricated structures and low embodied energy materials and systems (p.10).
- Structural systems using sustainable materials like timber, earth, straw (p.10).
- Ease of demolition and recycling (p.10).
- Long-life loose fit design (p.10).

Building Envelope Design,

- Relationship of openable area to lighting and thermal performance (p.10).
- Sustainable materials for paints, floor coverings, framing, insulation for glazed areas (p.10).

Lighting Services,

- Maximising available daylight use. For this purpose daylighting studies including daylight factor studies, daylighting simulations should be done (p.10).
- Selection and location of lighting components (p.10).
- Lighting management, controls to integrate natural and artificial light (p.10).

Electrical Power,

- Minimisation of electricity consumption, isolation of electrical circuits at night-time, optimised cable sizing, low-energy lifts (p.10).
- Combined heat and power generation systems to maximise total energy efficiency (p.10).

Heating System,

- Promoting passive heating techniques (p.11).
- Maximising the efficiency of active heating measures. Selection of heating method and fuel, combined heat and power, high efficiency heat emitters for the smaller quantities of

heat involved, air and water plant size optimisation, optimisation of controls including Building Energy Management systems, air heating systems and fully ducted systems-with optional free cooling (p.11).

- Input on life cycle costing calculations (p.11).
- Energy calculations to take account of passive gains (p.11).
- Combined heat and power on larger projects (p.11).

Cooling System,

- Maximisation of passive cooling techniques (Yeang 1999, p.258).
- Thermal mass and ventilation to promote passive cooling measures (ACE 1999, p.11)
- Modelling of temperature changes to predict internal in relation to ambient temperatures, advice on facade design, and modelling of shading and daylight solar gain (p.11).

Water Services,

- Minimisation of water consumption through component selection for water conservation and by re-use of grey water (ACE 1999, p.11) .
- Small-scale self contained waste treatment systems (ACE 1999, p.11).

Ventilation,

- Building modelling to maximise through ventilation and stack effect ventilation for cooling (ACE 1999, p.11).
- Analyse the wind conditons.

Cost Estimating,

- Comparative life cycle cost studies, for individual components and alternative systems, to incorporate initial cost, cost in use, cost of demolition and re-use including recycling (ACE 1999, p.11).
- Environmental cost accounting (ACE 1999, p.11).

Landscaping,

- Site assessment, including land contamination, methane, radon and landfill gas, hydrology (ACE 1999, p.11).
- Environment assessment, including ecological issues (ACE 1999, p.11).

- Soft landscaping for life cycle winter solar access, height of vegetation, shading, light reflection, sunlight penetration and shelter, prevailing wind directions and intensity, modelling of earth berms (ACE 1999, p.11).
- Passive cooling and urban design (ACE 1999, p.11).
- Indigenous vegetation, conservation and propagation(ACE 1999, p.11).
- Waste treatment plants (ACE 1999, p.11).

Briefing is a summary of whole work that outlines the job of the architects, consultants and client expectations. The process of arranging a brief with the client is mutually informative. Brief may change according to the client's intentions for building size, performance, cost and project timescale. The brief includes all information and requirements produced through dialogue between the client and the design team on the site. Building functional, environmental and special performance, project cost and timescale, post-handover maintenance and the budget should be negotiated with the client before further development in the design (ACE 1999, p.6).

The installation of the environmental design components will eventually increase the building cost, and the client may refuse to pay the extra cost for the building. The knowledge of architects about environmental design will be more than the client, explanation of a long-life, loose-fit, low-energy strategy and low running cost at this stage will help clients to understand the benefits of *er design* (ACE 1999, p.6). The architects' presentations are vital for the client to support their ideas. More effective way is to show simplified scientific information and show a portfolio of built examples.

Architects should review and agree design comfort standards with a view to reducing energy demand. The research on the site's topography, sun, wind, vegetation conditions will be useful for the future decisions on *heating*, *cooling*, *lighting* and *ventilation designs*. Preparing charts and data at this stage will solve the possible design problems in the future.

Architects need to explore the possibility of alternative structural systems and materials, which might influence the load-bearing capacity. They discuss performance of finishes, especially internal wall and floor finishes, and of window and external door materials, in connection with improved indoor air quality, as against ongoing maintenance requirements (ACE 1999, p.12)

Design strategies generally:

- Client should decide whether they will actively operate the environmental control systems like shutters a day-to-day basis or everything is to be automated (ACE 1999, p.12).
- Review and agree design comfort standards with a view to reducing energy demand (ACE 1999, p.12).
- Architects explain the need for climatic data on the site. Macro-climate needs to be obtain from meteorological stations and micro-climate survey work may be necessary (ACE 1999, p.12).

Building Use,

- Use patterns (daily, weekly and seasonal) affect environmental requirements and choice of structure and systems. Decisions on the period of the use whether the building is used at irregular intervals or regularly. Are there long holiday periods. Construct a use profile of the building. Occupants and activities at different times of day and week(ACE 1999, p.12).

Architects,

- Architects need to explain that the subject is not yet definitively researched and that much remains to be done in researching green urban planning and materials (ACE 1999, p.12).

Consultants,

- Decision on whether environmental, daylighting or energy consultants are appointed (ACE 1999, p.12).
- Decision on who pays for these (ACE 1999, p.12).
- Decision on whether client chooses consultants If so, investigate whether they have 'green' expertise or they need to be supplemented by specialists (ACE 1999, p.12).

- Architects need to ensure that the scope of appointments includes the requisite environmental advice (ACE 1999, p.12).

Heating,

- Architects should explain the possibility of passive measures and their contribution to performance (ACE 1999, p.12).
- Decision on whether the client use 7-day programmable controls (ACE 1999, p.12).

Cooling,

- Decision on whether the client will approve passive cooling measures if these are judged useful (ACE 1999, p.12).
- Decision on how precise is the level of environmental control required (ACE 1999, p.12).

Lighting,

- Decision whether daylight maximisation is a desirable goal (ACE 1999, p.12).
- Decision on whether the client pay will for passive infrared switching, for individual light switching, for photoelectric override of active systems (ACE 1999, p.12).

Ventilation,

- Decision on whether the occupant will operate manually operated trickle vents in windows(ACE 1999, p.12).
- Deciding on which areas required mechanically assisted ventilation(ACE 1999, p.12).
- Identify the possibilities of heat exchangers, discuss capital against life cycle costs (ACE 1999, p.12).

Water,

- Decision whether the client would pay for low-water WC cisterns and lavatory controls, spray taps (ACE 1999, p.12).
- Similar issues affects domestic appliances like dishwasher, washing machines (ACE 1999, p.12).

Waste,

- Discuss disposing of surface water run-off on site, and advice on the need for treating run-off from car parks (ACE 1999, p.12).

- Decision on whether composting of domestic refuse on site acceptable (ACE 1999, p.12).

Site Works

- Identify existing vegetation to be conserved and discuss how this affects the design (ACE 1999, p.12).
- Discuss the provision of sheltered and secure bicycle storage on site (ACE 1999, p.12)

Materials,

- Explore the possibility of alternative structural systems and materials, which might influence load-bearing capacity (ACE 1999, p.12).
- Discuss performance of finishes, especially internal wall and floor finishes, and of window and external door materials, in connection with improved indoor air quality, as against ongoing maintenance requirements.

Cost,

- Decision on what extent the client is concerned with life-cycle issues. Explain life-cycle costing by investigating client's intention for the building, short or long-life investment. It is not yet easy to demonstrate that green design increases capital value. It may be necessary to benchmark the building cost against that of comparable non-sustainable buildings.
- Try to obtain agreement that a measure of life-cycle costing may be factored into all design and specification decisions.

Timescale,

- Decision on whether the design team require more time at any stage in the process to explore design issues. For example: alternative site studies, daylighting studies, and heating and cooling calculations at sketch design stage, particularly if few persons are available to undertake specialist tasks.

Contractor,

- Discuss the steps needed to select the contractor and how the green design will impact on the construction process (ACE 1999, p.12).

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2.B.2 Design

This is a further stage that architect has the basic information about the site and the outline of design brief ready for architects to combine the site conditions. The progress of the design stage needs *preliminary studies, sketch studies, pre-project, basic project, execution of project, tender produce,* so that the project will be ready for *construction stage.*

In the **preliminary studies**, research and analysis should be done over the *site.* Research includes *topography*, *orientation*, *sun path*, *vegetation*, *wildlife*, *wind directions and site microclimate*. After all research and analysis are done, architects should decide the correct building type, the feasibility of the brief on the site. When deciding for the building type need to investigate the feasibility of the brief on the site and good practice examples of previously constructed building need to be overlooked as prototypes for their new design (ACE 1999, p.14). The overall shape of a building affects the amount of energy it will consume. To minimise heat transmission for a given enclosed volume, a building should be constructed with minimum exposed surface area. Making the building the right shape and the correct *orientation* can reduce the energy consumption by 30-40% at no extra cost (ACE,1999, p.60).This way unexpected performance of the building will be reduced. While architects are documenting the site conditions, advises from the consultants will help to avoid unsuitable design ideas. Early investigations on the site conditions can help to save energy and reduce the environmental impact of the buildings. Acting early for future problems that can happen in the life cycle of the buildings, will save money and time. Every issue needs to be considered about the site conditions because design solutions need to tackle with them otherwise, chain reaction of problems might occur. It will cost more in the future to solve the design problems.

Preliminary studies will generally accompanied by a report. The report includes the examination over the environmental impact of alternative strategies. It may be useful to incorporate a section to specifically identify the environmental issues. **Preliminary studies** explore the broad alternative design possibilities for the project, having investigated town planning, site conditions and existing urban

settlement. The report includes the examination over the environmental impact of alternative strategies (ACE 1999, p.14).

Decisions at **sketch studies**, early stage in the design are of the utmost importance, when the project requires a provisional direction. Architects need to define the general technical solutions envisaged with the help of technical meetings with the consultants. Then, architects should overlap the timetable expectation of the client, with the consultants and indicate the approximate timetable(ACE 1999, p.15).

The documents and services to be provided by the architects are an analysis of the *brief*, a summary of the thinking behind the proposed solutions and drawings to show a preliminary architectural solution in *sketch form* (Figure 2.19).

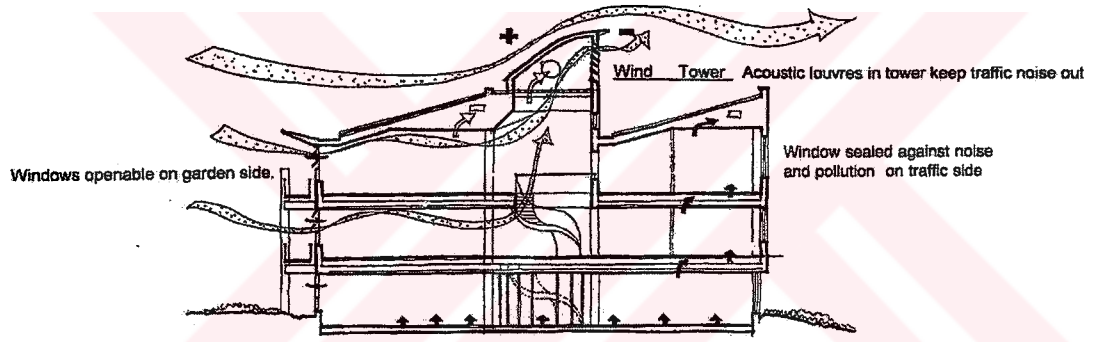

Figure 2.19 The ventilation diagram of the Ionica Building by R H Partnership (Edwards, 1999, p.64).

Site plan,

- The sketch form of site plan should give enough information on protection and use of pre-existing site characteristics like vegetation, landscaping, topography, water; site disposition for insolation, shading and shelter. Also the site plan should represent the orientation, zoning and general disposition of the site with impact on energy consumption (ACE 1999, p.15). Figure 2.20 is an example work that architects should prepare for their building sites.

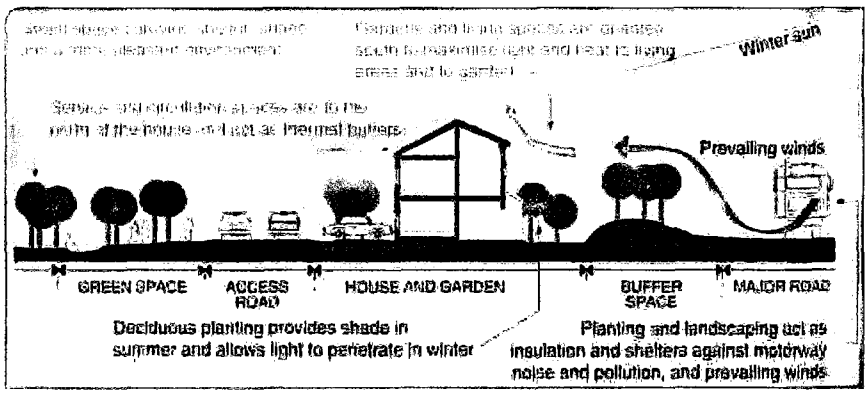

Figure 2.20 Site Strategy for Residential area (ACE 1999, p. 56)

Building Plan and Section (ACE 1999, p.56):

- At this stage, architects need to give approximate decisions on the section height and depth, number of floors and orientation to increase day lighting. The drawings should provide design decisions to enable passive ventilation using the stack effect and reduce heat loss. In Figure 2.21, typical sketch section drawing done by Short and Ford Partners presenting environmental strategy of the business units they designed.

Elevation,

- Broad proportions of fenestration, with effects on daylighting, ventilation, overheating on east, west and south facades, which can be passively controlled by the use of external shading devices.

Materials,

- Structural system (concrete, steel or timber) and external envelope, and their environmental impact.

At **Pre-project** stage the provisional direction previously sketched is amended and developed through plans, sections and elevations. Earlier decisions are confirmed or modified. The building acquires a definite form, layout, type of construction and method of servicing. Materials are proposed, a document prepared for the description of materials. The initial investigation of comfort and environment should be by numerical studies, generally with consultants (ACE 1999, p.16).

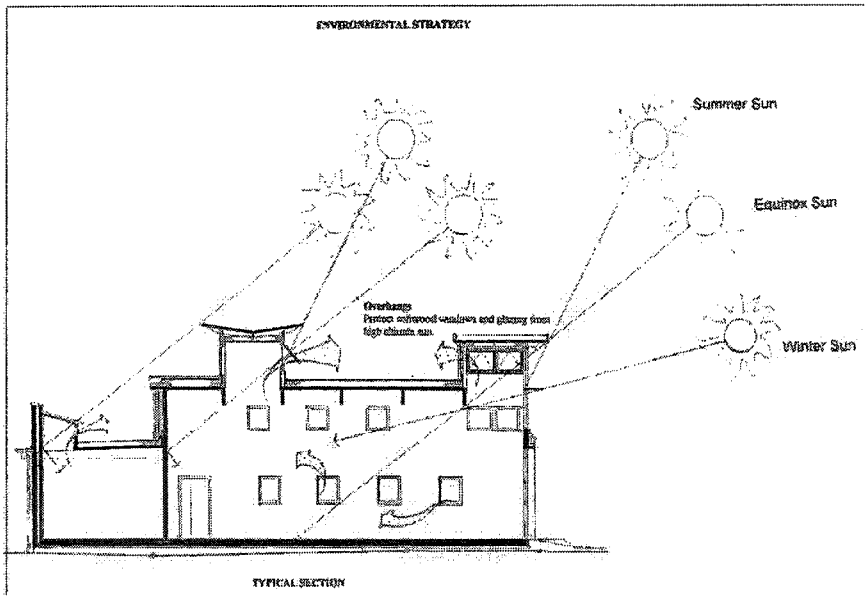

Figure 2.21 Environment strategy at business units designed by Short Ford and Partners (Edwards,1999, p.77).

In the scope of architect's services is to develop the general form of the project based on preferred solution and derived from the chosen design approach involving, examining the functional relationships between the different elements of the brief and the spaces provided, consultations with Public Authorities, coordinating the work of any technical specialists.

The documents and services to be provided include, a report explaining the general concept. Floor plans, elevations and sections prepared at 1:100 (for larger projects 1:200) with significant details at 1:50, site and landscaping plans at 1:200 (for larger projects 1:500). General timetable for the execution of the project and explanation of the technical principles with technical consultants' advice documents (ACE 1999, p.16).

Site Plan and External Landscaping,

- Consider layout and orientation of building groups in relation to insolation and over shadowing (ACE 1999, p.16).
- Consider size and location of hard surfaces, in relation to desired sunlight and shelter (ACE 1999, p.16).

- Use shelter planting to create protected and sheltered areas (ACE 1999, p.16).

Building plan and section,

- Optimise use of daylighting in habitable spaces (ACE 1999, p.16).
- In northern latitudes, zone areas such as sanitary, circulation and storage to the north (ACE 1999, p.16).
- Include air flow paths for natural ventilation in plan if the building is shallow and section by employing stack effect (ACE 1999, p.16).

Elevation,

- Consider proportions of glazing to opaque facade for daylight distribution and passive heating and cooling (ACE 1999, p.16).
- Control glare and overheating, particularly on east and west facades: consider shading devices external louvres or set backs, blinds (ACE 1999, p.16).

Materials,

- Consider use of structural thermal inertia to dampen internal temperature fluctions (ACE 1999, p.16).
- Consider sustainability and environmental impact of materials, embodied energy, impact on habitats, toxic emissions and ease of recycling or re-use (ACE 1999, p.16).

Consultants,

- Presentations should indicate how environmental principles will be developed at detailed design stage, and how proposals will be evaluated, with maximum use of passive systems (ACE 1999, p.16).

Technical principles,

- Consider combined heat and power to reduce primary energy use (ACE 1999, p.16).
- Provide outline illustration of environmental performance, particularly through plan and section diagrams for passive and active energy flows (ACE 1999, p.16).

Cost,

- Consider factoring environmental and life cycle cost into initial estimates (ACE 1999, p.16).

- Where higher initial cost is proposed this may be for better performance, improved environmental quality, lower life cycle energy and environmental cost.
  For instance, high quality as against poor quality timber window frames(ACE 1999, p.16).

Administrative Authorities,

- Consult about innovative propositions for fresh water supply, rain water disposal or reuse, grey and black water disposal (ACE 1999, p.16).
- If the building generates electricity like photovoltaic panels discuss buy-back with the utility company as necessary (ACE 1999, p.16).

At **basic project** stage, the technical consultants prepare submissions for architect, client and Statutory Authorities on the building service systems and building energy performance. For a standard form, the calculations should be prepared under headings, heating- cooling- lighting- fans, pumps, and controls- small power- total. Results can be compared to normalised performance indicators for that building type in the given climate, proving a good projection of building performance (ACE 1999, p.17).

Applications for building permit require definitive presentation of the design. For building regulations approval the principal environmental design issues will be those of sustainable materials and calculations for embodied energy and sometimes, of structural design as regards thermal mass (ACE 1999, p.17).

Site and building plans,

- Confirm earlier decisions on site and building plans on siting and positioning for insolation and shelter, form for over-shadowing, layout and extent of hard and soft landscaping (ACE 1999, p.17).
- Consider disposal of surface water within the site (ACE 1999, p.17).
- Consider treatment of polluted water from vehicle hard standings.

Section and elevation,

- Confirm floor to floor heights to maximise daylight and natural ventilation and avoid overheating (ACE 1999, p.17).
- Confirm facade proportions, and provision and design of external shading to prevent overheating (ACE 1999, p.17).

- Consider opening sections in windows for passive ventilation(ACE 1999, p.17).

Consultants,

- Consider long life and loose fit building structure and the adaptability of structure and services for different building use (ACE 1999, p.17).
- Long-term adequacy of load-bearing capacity (ACE 1999, p.17).
- Ensure accessibility to ductwork, pipes and wires, with removable covers, demountable trunking (ACE 1999, p.17).
- Size conduit drops in walls for easy rewiring (ACE 1999, p.17).
- Make calculations of building energy performance.

Detail design (Execution of Project), particularly of the external envelope; technical specification of building components and workmanship; and co-ordination of the engineering consultants particularly mechanical and electrical services, but also structural, have considerable implications for *er design.*

The design team should detail the external envelope for best environmental performance. For example the most sustainable material for glazing frames is softwood timber; however in long-life building, thermally broken composite frames may also be an appropriate choice (ACE 1999, p.18). The design of windows is a key element affecting building energy performance and involves heat loss, solar heat gain, daylight and visual access to the exterior. The overall U-value of a window depends on the area weighted effects of the centre of glass component; the edge of glass component that accounts for the higher heat flow rate through the access to the exterior also cause an increase in wintertime solar spacer, and the type of frame. Design should evaluate the overall U-Value of the window system, not just the glazing. Window design and its attendant solar control strategy should maximise useful winter solar heat gain and minimise excess solar gain at other times. One should minimise the use of tinted or reflective glasses to reduce excess solar heat gain since these also reduce daylight and obscure visual gains (Edwards 1999, p. 56).

Locally produced masonry; clay bricks, concrete blocks and tiles reduce the environmental impact of transporting heavy materials (ACE 1999, p.19). The energy needed to transport bulk materials is generally a function of distance travelled, mode of transport and mass of material hauled. Materials with low density such as insulation, however tend to use disproportionate amounts of energy for transport due to their bulk (ACE 1999, p.114). It's advisable to use local materials to reduce the impact of transport on the environment.

Site plan,

- Specify rainwater soak-aways and ponds (ACE 1999, p.18).
- Closed sewage treatment (ACE 1999, p.18).

Section and Elevation,

- Select glazing frames for best performance (ACE 1999, p.18).
- Glazing to incorporate low emissivity coatings (ACE 1999, p.18).
- Use trickle ventilators, or passive ventilation strategies (ACE 1999, p.18).
- Insulate beyond building regulation requirements in sustainable materials (ACE 1999, p.18).
- Detail to avoid cold bridging (ACE 1999, p.18).

Materials,

- Specify for long life and low embodied energy (ACE 1999, p.18).
- Masonary components of local origin, roof finishes for long life, greater thickness of sheet flooring timber boards of low formaldehyde content, lime-based plaster mixes and acrylic or water based paints are healthier (ACE 1999, p.18).
- Monitor consultants to ensure strategy agreed at earlier stages is implemented (ACE 1999, p.18).

Technical Principles and Application (ACE 1999, p.18),

- Specify mechanical services components for good energy performance over long life (ACE 1999, p.18).
- Minimise hot water pipe lengths from storage to point of use.

In **Tender Procedure**, tender documents should take account of environmental principles. Some contractors, particularly specialist mechanical, ventilation and

sanitary engineering contractors, will be required to provide detailed design services as part of their works (ACE 1999, p.19).

Architects should prepare and issue the tender documents, to assist the clients in letting the construction contracts. Then, the clients will choose the tendering method, whether by a main contractor, a package deal, and a number of specialist contractors. Architects should examine and verify tenders received from the contractors and use them in any negotiations. The documents and services to be provided include tender documents and a report on tenders received to include tender comparisons and analysis (ACE 1999, p.19).

At this stage, architects should plan the use of the construction site. They need to limit contractors' working space to protect existing flora and fauna. A plan should be prepared to give directions on materials and storage to minimise construction waste (ACE 1999, p.19). Architects should ensure that the contractors have a comprehensive energy police for site operations, including waste avoidance, economic use of water and eco-friendly disposal of demolished materials and this policy is acted upon during construction (Jones 1998, p.12).

Site plan (ACE 1999, p.19),

- Limit contractors' working space to protect pre-existing natural features and vegetation. (ACE 1999, p.18).
- Specify to conserve and re-use top soil (ACE 1999, p.18).
- Give directions on materials handling and storage to minimise waste (ACE 1999, p.18).

Specialist Contractors (ACE 1999, p.19),

- Make *er design* requirements explicit in all tender packages, especially in specialist packages for design and construct works. These requirements will include directives on the use of as-found material; on construction waste minimisation, handling and disposal; and on the use of environmentally friendly cleaning materials.

2.B.3. Construction

At **construction stage**, architects check the general conformity with the designs of works being executed. They provide any instructions needed for the contractors to co-ordinate and correctly execute the works. The documents and services to be provided include preparation of contract documents, including the contract, drawings, specifications and any guaranties; monitoring the construction work in accordance with the project timetable, applicable rules and standards, and the contract documents with regard to building dimensions, quality standards and appearance; issuing instructions for executing the works; arranging and recording of site and progress meetings; making periodic valuations of the works (ACE 1999, p.20).

During the preparation of these documents, different from other methods of construction, special concern should be given to the environmental issues. At inspection stage, architects should make sure that adequate protection of *existing landscape*, *water*, *vegetation* and other *site conditions* maintained by the contractors.

Check Proper procedure (ACE 1999, p.20),

- Gathering and storage on site of topsoil for subsequent re-use (ACE 1999, p.20).
- Specified components and materials are provided (ACE 1999, p.20).
- Adequate protection of existing landscape, water, vegetation and other site features.
- Correct handling and storage of materials (ACE 1999, p.20).
- Use of any as-found elements such as hardcore or earth (ACE 1999, p.20).
- Storage for recycling of polythene and cardboard packaging.
- Use of environmentally friendly cleaning agents.

Check construction standards (ACE 1999, p.20),

- Correct installation of insulation (ACE 1999, p.20).
- Correct working of materials for indoor health (ACE 1999, p.20).
- Weather tightness of opening elements (ACE 1999, p.20).

- Sealing of openings around pipes penetrating the external building envelope (ACE 1999, p.20).
- Vapour control membranes (ACE 1999, p.20).
- Correct disposal of toxic waste (ACE 1999, p.20).
- Correct disposal of waste materials and packaging (ACE 1999, p.20).

Advice on Building Operation and Maintenance:

- Before to acceptance of the building for the client, the architect inspects the building for final completion in accordance with the drawings and specifications. Architects should prepare maintenance folder to guide the clients during their occupation in the buildings. The folder should include documents about the manuals for passive systems and performance of service installations, component maintenance and repair, a safety file with advice on safe maintenance and repair. Whether the design features are passive or active, the client will best optimise building performance by having the working of the building explained and illustrated (ACE 1999,p.21).

Correct building maintenance:

- Maintaining and renewing floor and wall finishes selected for health and environmental performance (ACE 1999,p.21).
- Regular cleaning of windows and luminaries (ACE 1999,p.21).
- Maintaining internal and external planting (ACE 1999,p.21).
- Use of sustainable, non-toxic, biodegradable cleaning agents (ACE 1999,p.21).
- Application of paint and thin film coatings in properly ventilated spaces (ACE 1999,p.21).
- Annual inspection of active systems to check continued efficiency of boilers, cooling equipment, radiator valves, infrared switching, heating and cooling controls (ACE 1999,p.21).

Operating Energy management systems,

- Operating systems to prevent overheating in summer like movable shading, night-time cooling shutters (ACE 1999,p.21).
- Operating ventilation systems both mechanically assisted and passive like fans, natural ventilation to optimise balance of ventilation, heating and cooling demand (ACE 1999,p.21).

- Operating the building to maximise heat gain in the heating season, control of night-time ventilation, operating blinds to maximise insolation, closing internal doors to retain captured heat, opening shutters to promote desired ventilation (ACE 1999,p.21).
- Illustrating the mechanical system controls such as programming time clocks, operating weather compensating controls, setting thermostatic radiator valves, seasonal manipulation of flow temperature in heating system.
- Operating electrical installations, correct replacement of light fittings, discussion of switching on lighting and power, lighting sensors, power zoning.
- Operating to maximise the use of daylight and minimise use of artificial lighting.
- Avoiding peak electricity costs at 7:30 and 17:30 by periodically shutting down large plant.

Monitoring environmental performance (ACE 1999,p.21),

- Investigate energy consumption through an entire heating and cooling season, by reference to utilities invoices or electricity gas, other. These can be totalled over a year and consumption in kWh/m2 readily derived. This can be compared with reference figures for an assessment of the overall performance of the building users' comfort, particularly in relation to overheating in the cooling season, where air conditioning is not provided and natural cooling methods are employed and user satisfaction in relation to daylight availability. Questionnaires can be helpful in this regard.

- Monitor room temperatures, either by simple maximum/minimum thermometers or by thermometer linked to computerised recording system, to establish the effectiveness of heating or cooling installations and help determine whether active installations are over-utilised (p.21).

- Water consumption, by monthly and yearly meter readings and a daily consumption in litres per head calculated from the number of building users. Data may be checked with reference to established bench marks to establish the level of performance (p.21).

2.B.4 Refurbishment

When the architects are working on existing building, they need to adapt the structure for new uses and solve the existing environmental problems which are the air quality and movement, condensation, toxins from existing construction materials, noise pollution caused by traffic and neighbours. For the life cycle management, they should reuse existing building components and materials. This way, less energy and materials will be used in the construction. Conservation of resources and energy can be accomplished by the use of recycled materials as well as from agriculture and industrial by-products.

Identify the building's potential for environmental improvement (ACE 1999,p.23),

- Increasing daylighting through roof lighting.
- Reducing overheating through the use of external louvres or blinds.
- Reducing heating demand through installation of draught lobbies and by adding insulation to external walls and roof.
- Envelope performance by better windows and doors
- Natural ventilation by adding opening sections to windows and roof lights
- Controlling ventilation and casual infiltration
- Performance of active systems through better controls, time clocks, thermostats, building energy management systems, and more efficient fittings like lights, heat emitters.
- Indoor air quality by substituting natural for synthetic finishes, linoleum, water based paints.

Considerations during refurbishment (ACE 1999,p.23),

- Improve controls on active systems.
- Improve thermal insulation.
- Passive climate control devices fixed or movable shading.
- Retrofitting sustainable components such as solar water heaters and photovoltaic cells.
- Use of renewable and recycled sources of materials (Yeang 1999,p.171).
- Durability and flexibility of the proposed building (Yeang 1999, p.171).

C- CASE STUDIES

2.C.1 Reno Post Office, Nevada, USA

In the book, Sustainable Practices(1997) edited by Craig Langston, there are several case studies which are valuable examples of how good design can improve worker productivity. The Reno Post office was refurbished in 1986 with the objective of reducing energy costs. The renovation design changes cost US$300,000 and design based on a lowered ceiling and improved lighting. The resultant energy and maintenance savings came to about US$50,000 Per year which represented payback period of 6 years. The major benefit through arose in the unintended area of worker productivity. A quieter and better lit work environment facilitated improvements in work output and quality. Productivity increases stabilised at 6 Per cent after one year and the mistake rate dropped to the lowest of any post office in the country (Langston,1997, p.201).

2.C.2 Recycling of Waste, Demolition of IBM Laboratories, Wincester, UK

In Brian Edwards book Sustainable Architecture(1999), life-cycle management is discussed with demolition of IBM Laboratories. IBM has a general recycling policy which seeks to reuse or recycle about 50 Per cent of the non-hazardous waste produced by the company. When in 1993 the company decided to demolish an office block in the heart of an estate of computer laboratories at Hurnsley near Winchester, it decided to collapse the 1960s building.

With the IBM's recycling policy, resulted in a demolition contract where 90 Per cent of materials were recycled. This was achieved in a contract only two weeks longer than conventional demolition contract and at no additional cost. The demolition contract required the dismantling of the eight storey office block floor by floor, rather than using conventional method demolishing the whole. Dismantling more

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environmentally friendly gave opportunity of salvaging many of buildings components.

The contractors who tendered for the demolition contract were aware of IBM's policy on recycling. The selected contractor used skips at the site to segregate demolished material, so that the different building elements and components could be recycled. The contractor had first to produce a statement for IBM indicating where the recycled materials were to go to ensure that recycling wasn't a hollow gesture. Daily records were kept of the movement off site of skips and some were followed to ensure that fly-tipping wasn't taking place (Edwards 1996, p.196).

Of the materials recycled only sanitary ware, doors carpets and blinds were directly reused, the remainder was rendered down to more basic material. Glass, a major component in the building recycled to a plant in West Yorkshire, concrete was transported to be crashed as hardcore, steel was melted down. Materials which couldn't be reused, such as plasterboard, were taken by skip to approved landfill sites.

IBM monitored proceedings from beginning to end, seeing this demolition contract as highlighting green needs for the future. The documentation of the contract held by IBM records the destination of the materials and subsequent reuse or recycling.
The contractor was able to sell the waste materials, thereby reducing their costs. Unfortunately some recycling plants were some distance from the site adding the contractor's costs and effecting the energy equation of the whole operation. The value of the waste was often less than the cost of energy to transport it. If there were local recycling plants the environmental benefits have been considerably greater.
In Europe 15 Per cent of building materials recycled though it is said there is a potential to be increased to 70 Per cent. This can be achieved by architects if they design and specify for reuse of existing materials (Edwards 1996, p.197).

CHAPTER 3

CONSCIOUS DECISIONS THROUGHOUT THE DESIGN PROCESS OF ENVIRONMENTALLY RESPONSIVE ARCHITECTURE: KEN YEANG'S DESIGN METHODOLOGY UNDER FOCUS

The purpose of chapter two was to assemble the knowledge of *er design* in within a framework which will encourage people working on *er design* to relate to each other in a consistent manner, and to help those outside design field to perceive it. Along with the analytical survey of *er design*, the social and political strategies were discussed in respect to the roles of academic institutions, manufacturing industries and governments in maintaining continuous consciousness.

The methodology employed in chapter two, attempts to assert that the knowledge gathered through 'research by design', that is, research carried out during the professional practice of architecture, is as vital as the knowledge gained through theoretical and analytical studies by the academic.

For *er design* to proceed further, there is a need for interconnections between theoretical aspects and practical results. One theme emerging from my experience on the subject is that when architects are thinking about *er design* issues, they would like to know if the techniques has previously worked out. For this purpose, in chapter three, I will conduct an analytical study on Prof. Dr. Ken Yeang who has academic background and contribute exciting work while practising his theoretical ideas into physical reality.

3.1 YEANG'S ARCHITECTURAL BACKGROUND

Yeang's architectural education began at the Architectural Association[1], a private architecture school in London, England, in 1966. Yeang finished his university and diploma degree there. Later, Yeang continued to PhD at Wolfston College, Cambridge University.

Yeang's first year tutor in his university degree, at the Architectural Association was, **Elia Zenghelis** later who became the member of Office for Metropolitan Architecture (OMA) group with **Rem Koolhaas** and **Zaha Hadid**. Zenghelis gave enthusiasm to Yeang towards the modern movement. After Yeang completed his degree at the AA, he went back to Asia to work in practice of Stanley Leong as one of several site architects on the Singapore Mandarin Hotel, an internship that gave him experience in building practice and drawing (Powell 1999, p.23-24).

In 1971, Yeang returned to the Architectural Association to complete his diploma course. His tutors included Ron Herron, a member of the *Archigram*[2] group, who together with *Cedric Price* 'offered the most compelling visions of the future and technological fantasies' (Yeang 1994, p.8). Yeang describes Herron's teaching saying ' had a sharp eye and a gift for succinctly distilling his criticism into two or three sentences'. The influence of the Archigram group would later surface in Yeang's own work on the MBf Tower (1993) and the 1998 project for the Expo 2005 Nagoya Hyper Tower[3] (Figure 3.1) (Powell 1999, p.8).

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[1] See Appendix M.

[2] **Archigram.** English group formed in 1960 by Peter Cook. Their fantastic, utopian space-age visions of a flexible, disposable, plug-in Pop architecture in rapturous candy-colors were unrealized, but influential Peter Cook's Montreal Tower Project (1963) is a prototype High Tech design. The 'machine-look' was anticipated by Michael Webb in his furniture Manufacturers Project, 1957 which resembled an automobile engine Archigram disabandoned in 1975, their Capsule at Expo 70, Osaka, being almost their only realised project.

[3] **Expo 2005 Nagoya Hyper-Tower.** A six-hundred-metre-high mega structure, including a transportation terminus, an information centre, auditoria, hotels, an amphitheatre, cultural institutions, a conventional hall, LRT stations, a helipad, police stations, government buildings, an arts and crafts village, international exposition pavilions, administrative offices, commercial space and light residential accommodation.

The vibrancy of the AA staff in the 1960s and early 1970s, and the investigative nature of the school, left a lasting impact on Yeang. The diversity of the students who later became significant architects in their own right produced a studio environment with high level of creativity and energy (Powell 1999, p.9).

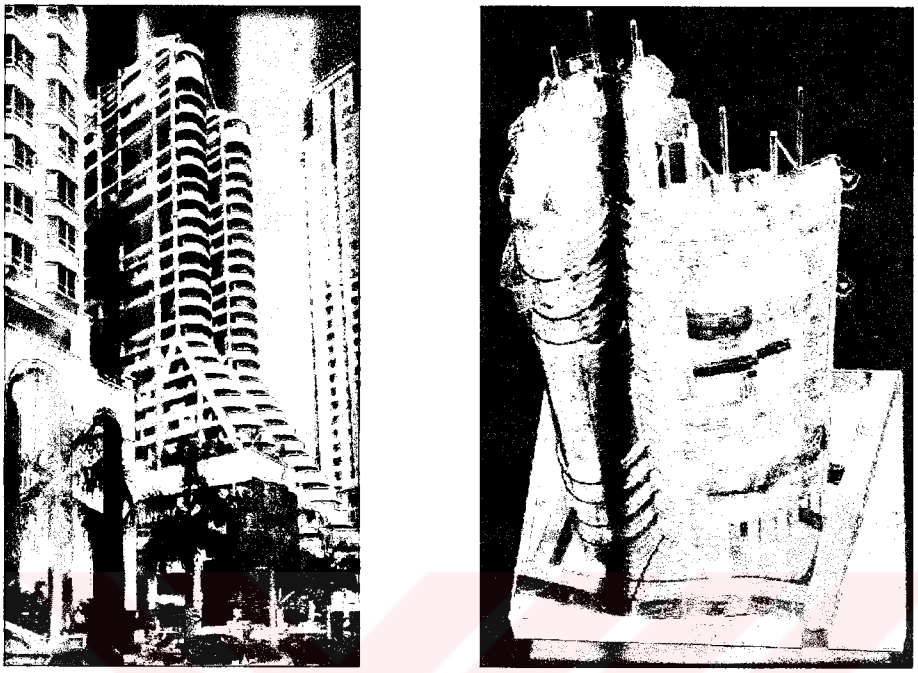


Figure 3.1 MBf Tower (1993) and Expo 2005 (1998) projects (Yeang 1999, p.54 and p.153).

After Ken Yeang concluded his education at the Architectural Association, he continued his PhD degree at Cambridge University. During his PhD, Yeang wrote a doctoral thesis titled A Theoretical Framework for Incorporating Ecological Considerations in the Design and Planning of the Built Environment. The study of the thesis was, to look at the built environment and its' relations to the natural systems of the biosphere. Yeang's thesis let him to undertake coursework at the Biology Department of Cambridge University where he developed his knowledge in ecology and the properties of biological systems. Yeang combined his biology research findings with his architecture thesis. His research involved the study of environmental biology and ecology, and their relationship to built form and design. In Yeang's architectural career, his thesis established the essential agenda (Powell 1992, p.17).

While Yeang was at Cambridge University, for one semester he went to Pennsylvania to undertake a landscape programme under Prof. Ian McHarg who headed the Department of Landscape Architecture and Regional Planning at the *University of Pennsylvania.* Prof. Ian McHarg is a landscape architect, planner, teacher and writer, concentrated on environmental designs in urban planning. Yeang found McHarg's passion for the protection of the environment overwhelming and he was influenced by McHarg's methodology (Powell 1999, p.12).

When Yeang met Kisho Kurokawa in London in 1973, Kurokawa had urged the Yeang to write a book, remarking that his own first book on Metabolism was written when he was twenty-four years of age (Powell 1999, p.11). As Kurokawa had predicted, the discipline of writing forced Yeang to organise his ideas. It helped to spread his experiences and at the same time revealed gaps in his knowledge. Yeang is one of a small but enlightened group of practising in Asia outside academia who publishes (Powell 1999, p.34-35).

In 1985, Yeang published his PhD thesis, using the same title of Prof. Ian McHarg's book Design with Nature(1969). Yeang says it's not a coincidence to have the same title as Ian McHarg's book because the content of his book 'takes off from where McHarg finished. As McHarg being landscape architect and planer, his book took ecological design up to planning level where as Yeang's book takes ecological design up to level of architecture (Powell 1999, p 72).

The knowledge that Yeang gained in his short education with the landscape and macro-planning course at the University of Pennsylvania complemented the earlier experience of the Architectural Association and the Cambridge School of Architecture. In the process, he acquired what Alan Balfour has referred to as 'the heady vision of the Architectural Association, the determinism of Cambridge and the environmental morality of Penn'. These were the raw ingredients he took back to Kuala Lumpur (Powell 1999, p.65).

The books which are written by Yeang includes[4]:

- Tropical Verandah City in 1986.
- Tropical Urban Regionalism' in 1987.
- Bioclimatic Skyscraper in 1994.
- The Architecture of Malaysia in 1995.
- Design with Nature in 1995.
- The Green Skyscraper in 1999.

Yeang's theoretical ideas and projects are also documented into two books by Robert Powell[5],

- Rethinking the Environmental Filter, 1989.
- Rethinking the Skyscraper, 1999.

When Yeang's theoretical ideas and projects published in books, they become valuable information for architects, consultants and clients. Yeang contributes influential ideas and projects for the development of *er design*.

3.2 YEANG'S DESIGN METHODOLOGY

In the early years of Ken Yeang's practice, he developed an attitude and a particular working method that achieved innovative results related to climate-driven theory in projects for commercial clients (Yeang 1994, p.11). Yeang called this methodology *Research Development and Design (RD+D)*. Yeang's insistence on building his research and constantly improving architectural production, achieving projects with less consideration on the ideas of the profit driven clients, helped him to hold a leading position within a field of international architects. Yeang is noted for his

[4] See Appendix N.

[5] **Robert Powell**, architect and urban planner, has lectured at universities in the United States, Japan, Australia and Europe. He is a former editor of the Singapore Architect and his previous publications include *Rethinking the Environmental Filter (1992), The Tropical Asian House (1996), The Urban Asia House (1998),and Rethinking the Skyscraper (1999).*

design of *roof and filter systems* for climate control energy and the use of *gardens in the air* in his high rise buildings (Yeang 1994, p.12).

Ken Yeang's design methodology involves an approach to the craft and practice of architecture that demands research on the *basis for design*. Every project part of *Research Design and Development (RD+D)* is the testing ground for *er design* ideas. Yeang is systematically at work on the whole built environment. This attitude is consistent with his first proposals at Cambridge University and his projects (Yeang 1994, p.14).

Alan Buffour describes Yeang's work, in his forward to Bioclimatic Skyscrapers(1994) as:

> Two distinct and related qualities are present in the architecture of Ken Yeang. The first is the ingenious and aggressive body language of the work as it struggles to reconcile the discontinuity between architectural form and climate (Yeang 1994, p.7).

'Research by design is a critical factor in the continuous improvement of Yeang's 'differentiated product'. Smaller projects that come to the practice are used to test ideas that are then selectively applied to skyscrapers and other large building types. He divides the site into a theoretical area that explores the ideologies behind designing for buildings with *er design* strategies.

Ken Yeang's own house, the prototype, Roof-Roof House completed in 1985, reflects his agenda, and it was his first internationally known project. It was a testing ground for Ken Yeang to put his ideas into reality. After achieving a success from the results of the project, Ken Yeang continued developing his *er design* ideas on other buildings. He gave more interest to the design of skyscrapers because increase in land prices and population, also the market boom in Malaysia forces the buildings to go higher. He realised the need for skyscrapers and decided to develop his er design ideas towards the construction of environmentally sound skyscrapers.

According to Prof. Dr. Ken Yeang, the success of the project depends upon the creativeness of architects and the inventiveness of the solution they generate to address the limitation and opportunities presented by the site and in the design problem. The more architects concern over the principles of environmental issues in the progress of the project stages; the end result will be resulted with environmentally friendly building (Yeang 1999, p.29).

Ken Yeang divides the development of strategies on *er design* in two justifications. One is comfort- based rationale which are *thermal* and *visual comfort* of the occupants in the building and the other one is a *passive, low energy use* based on regional climate and ecology (Yeang 1994, p 17). Ken Yeang developed his projects on *passive* considerations, sun and wind. The building form and function of his designs mainly generated from the orientation to the sun path and wind directions (Figure 3.2).

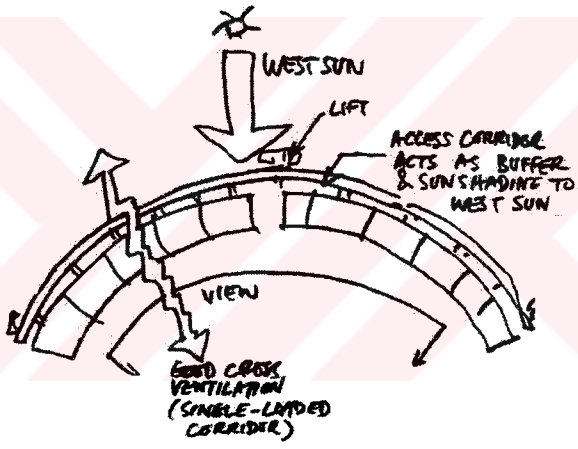


Figure 3.2 Conceptual sketch showing shading and ventilation design strategy for Casa-Del-Sol Apartments (Powell 1999, p.66).

For the skyscrapers, mainly offices, the arrangements of the cores determined by sun path diagram and the position of buffer zones (Figure 3.3). Cores include natural ventilation for toilet modules and fire stairs. Orientation determines the position of glazed areas. Sun shading is achieved with balconies or skycourts that create buffer and provide both shade and more outside space (Figure 3.4), coupled with planting that is applied over the entire elevation (Yeang 1999, p.87).

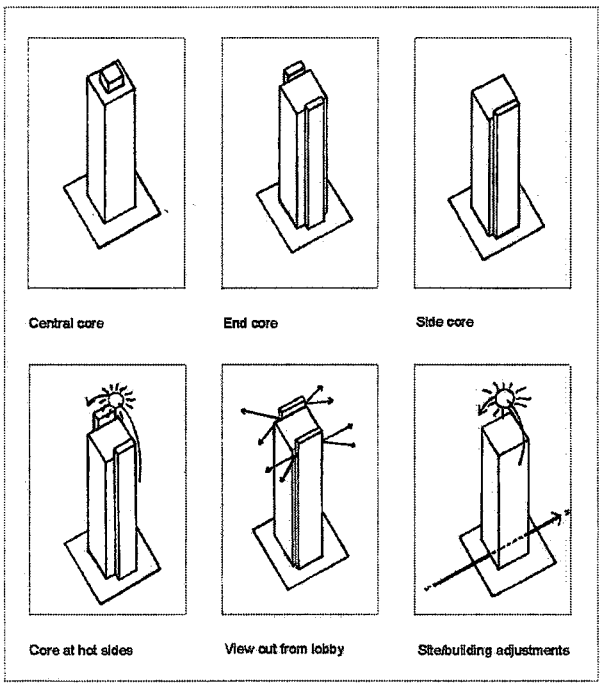


Figure 3.3 Building configurations (Yeang 1999, p.28).

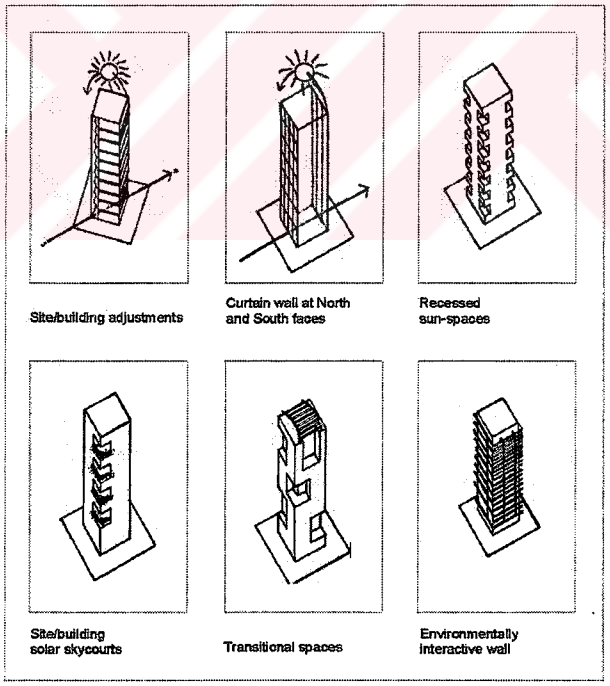


Figure 3.4 Environmental filter (Yeang1994, p.29).

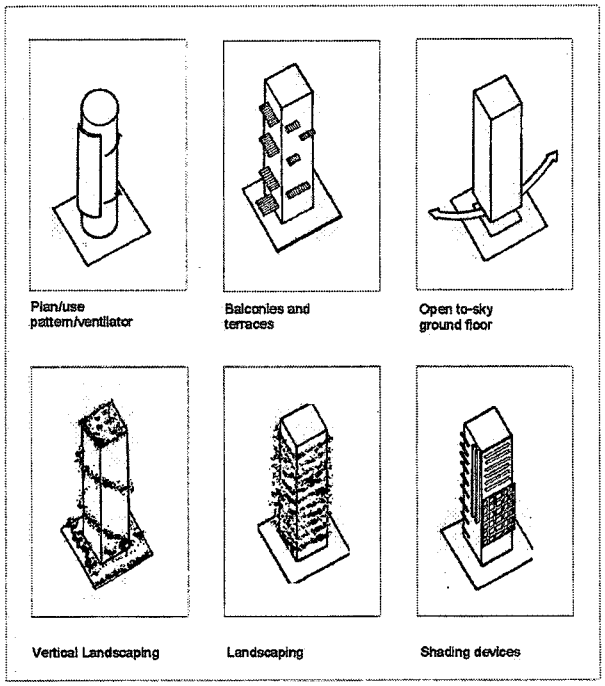


Figure 3.5 Environmental filter (Yeang 1994, p.29).

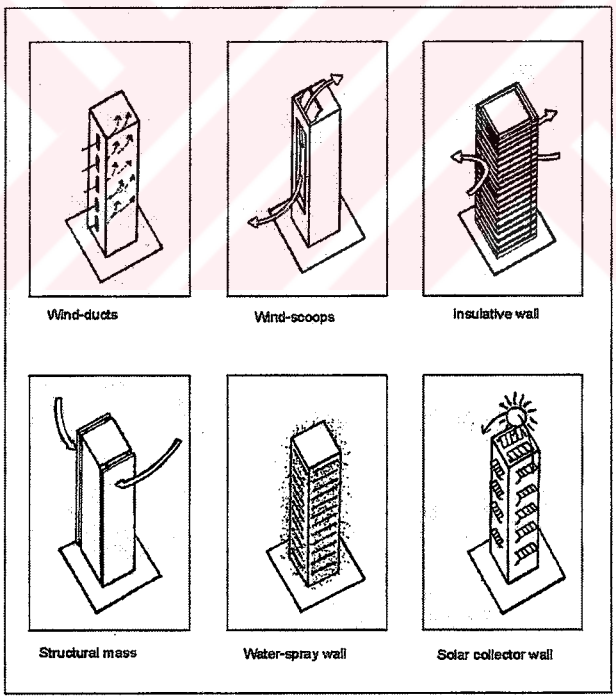
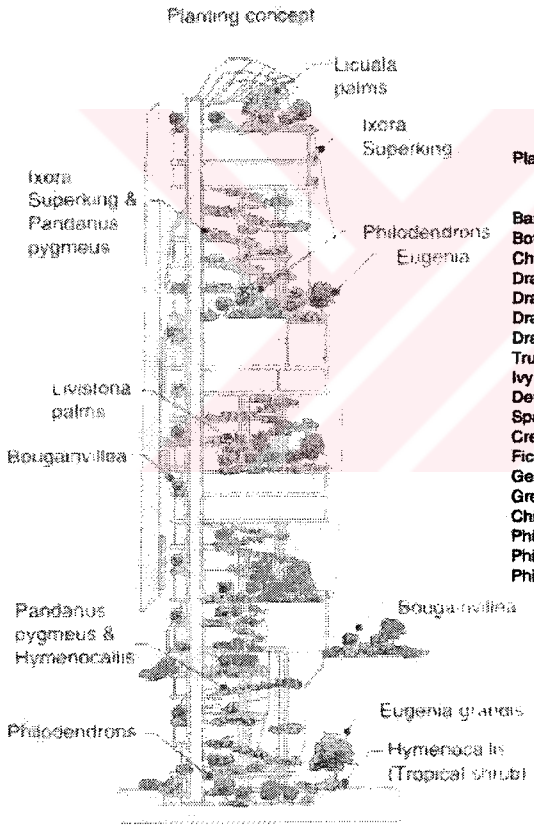


Figure 3.6 Facade design (Yeang 1994, p.31).

Wind projects are either for high-rise offices or for linear cluster apartment towers (Figure 3.6). The techniques used include opening up the plan into clusters that allowing air movement related to prevailing winds and orientation. Ideas include the position of wind-wing walls and sky courts, allowing air into the inner spaces for natural ventilation. Incorporation of sky courts in skyscrapers enables Yeang to recreate existing ground-level conditions in high office spaces (Yeang 1999, p 89).

Vegetation is an important aspect of place, besides being ecologically vital (Figure 3.7). Most of Yeang's skyscrapers feature vertical sometimes spiralling, and gardens that are used for shading, cooling and filtering. Theoretically there are three ways to relate buildings and planting. By juxtaposition where one material is placed



Plant	Form-aldehyde	Benzol	Trichloro-ethylene
Banana	89	–	–
Bowstring hemp	–	53	13
Chrysanthemum	61	54	41
Dracoena deremensis (Janet-Craig)	–	78	18
Dracoena deremensis (Warneckii)	50	70	20
Dracoena deremensis (massangeana)	70	–	13
Dracoena deremensis (yellow-variegated)	–	79	13
True aloe	90	–	–
Ivy	–	90	11
Devil's ivy	67	73	9
Spathe flower	–	80	23
Creeping hairy spurge	67	–	–
Ficus benjamina	–	–	11
Gerbera	50	68	35
Green lily	86	81	–
Chinese evergreen (Aglaonema)	–	48	–
Philodendron (domesticum)	86	–	–
Philodendron (oxycardium)	71	–	–
Philodendron (selloum)	76	–	–

Figure 3.7 Design strategy for vegetation (Yeang 1999, p.241and p.252).

next to the other, as in the use of planter boxes. By intermixing, as in the combining or interspersing of large areas like skycourts and quantities of vegetation with inorganic areas or surfaces. By integration, the ideal condition where there is seamless intermeshing of inorganic and organic material (Yeang 1994, p.24).

3.3 MY PROFESSIONAL EXPERIENCE IN YEANG'S OFFICE

After I completed my architectural education in University of East London, I was advised to work for Prof. Dr. Ken Yeang in Kuala Lumpur, Malaysia. I commenced to work for Ken Yeang in July 1997, to complete my work experience which was part of my education in UK. During experience in Yeang's office, I found an opportunity to develop my theoretical ideas into the physical reality.

In my first meeting with Ken Yeang, he explained the working method in his office. There were six-teen projects in the office, mainly skyscrapers, competition projects, housing and interior design projects. Every project had the *senior project architect* who is in charge on the overall project. Ken Yeang defined my job in the office as a *design architect* who works in collaboration with *senior project architects*.

In Ken Yeang's office the medium, in which all the activity finds expression, is the design process itself and the crucial structure provided by his own agenda for his research programme. The office had two types of working group. One is based on Yeang's methodology, *Research Development and Design (RD+D)* and the other group based on *Profit Making Designs*. *The Research Development and Design (RD+D)* group designs the competition projects and the prestige buildings that are aimed for Ken Yeang's international profile. There is long and precise design process compared to the profit making projects. *Design architects* shifted from one project to another depending on the stage of the project and their abilities. Ken Yeang has the overall control over everyone in the office. He has daily meetings with all the project teams and makes sure that there is progress in the designs.

As a result of Yeang's working system, I worked on eight projects at different design stages in part of *RD+D group*. The types of projects include offices housing schemes, canopy design and competition projects. One of the significant projects that I worked on was The Quandernario Technological Collage in Venice, Italy. It was a competition about facade and internal environmental system design for the college's existing building.

3.4 ANALYTICAL SURVEY ON YEANG'S DESIGN WORKS IN PROJECT STAGES

Most of Yeang's completed er design projects contribute valuable information for people working on the field. Analysing Yeang's architectural works may provide brief description for the development of er design method. Some of the design strategies that were discussed in the second chapter of this thesis are experimented in the design works of Yeang.

Yeang's buildings draw on both ancient experience (for instance making maximum use of prevailing winds to ensure cooling through ventilation) and sophisticated modern technology. Yeang contributes to development of er design by testing existing design strategies to push the limits on aesthetic attitude. After completion of each project, Yeang is rigor to correct the defaults or develop the design further, for his next project.

Three projects which were chosen, are significant projects for Yeang's continuous progress in his design agenda. These projects are the Roof Roof House(1984) which is Yeang's own house which helped him to be recognised internationally, second, Menara Mesiniaga (1992) got Aga Khan award and third project The Quandernario Technological Collage (1998) competition project in Venice, Italy. All three will be discussed in conjunction with the issues raised in the second chapter of this thesis.

YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

3.4.1 The Roof-Roof House (1984), Kuala Lumpur, Malaysia

The mood of technical experimentation that was nurtured in Yeang in his AA days is fully expressed in the Roof Roof house project (Powell 1999, p.116). Indeed, there

Table 3.1 Design strategies for the Roof Roof House (by Eray Bozkurt).

DESIGN STRAGIES FOR THE ROOF ROOF HOUSE	
SITE CONDITIONS	
Climate:	Tropical (see Figure 2.4). Microclimate conditions are important
Topography:	Flat land near rubber plantation prevents unwanted wind.
Orientation	North-south orientation with the ground prevailing SE and NW winds.
Vegetation	The land is free rubber plantation
Wildlife	The land is free from rubber plantation. No distruction to wildlife.
Wind	Prevailing SE and NW winds
Sun	Tropical conditions
Humidity	Humid
Temperature	Tropical season
Precipitation	
BUILDING	
Building Envelope	Two storey house
Shading	Outer curved roof acts as a solar filter to the rest of the house (Figure 3.5). Shadow study (Figure 3.7)
Indoor Air Quality	North-south orientation with the ground prevailing SE and NW winds.
Material Selection	Brick and concrete structure. Non-toxic paints.
Thermal Mass	Outer curved roof acts as a solar filter also adjusts heat gains.
Air Velocity	Calculated for one person occupation
Use Patterns	Standard house use patterns
Relative Humidity	The pool helps to adjust the humid conditions in the building
Clothes and Appliances	There is no specific considerations
OPERATIONAL SYSTEMS AND SERVICES	
Heating	Tropical climate no heating is required.
Cooling	Passive cooling. The movable internal glass partitions manupulated to control the ventilation.
Lighting	Hot air cooled over the pool water by evaporation before entering the living spaces.
	Natural and artificial lighting.
Water conservation	There is no specific considerations
LIFE-CYCLE MANAGEMENT	
Recycling	There is no specific considerations
Reuse	There is no specific considerations
Durability	There is no specific considerations
Waste	There is no specific considerations
Remanufacture	There is no specific considerations
Repair and Maintenance	Requires future repair and maintenance to adjust the building to current use patterns.

are so many ideas incorporated in this building that Haig Beck, the Australian architectural critic, was moved to exclaim that , 'the house lacks the scale to adequately carry all the experimentalism packed into it' (Powell 1999, p.116).

The Roof-Roof House is located on the outskirts of Kuala Lumpur, near a rubber plantation. It was intended to be designed for Ken Yeang's own use. The Roof-Roof House was one of Yeang's earliest experiments in the application of *er design* principles to residential design and develop a prototype for his other architectural works. In particular, it explored the roof as the fifth facade. The two-storey house was an attempt to put all his early ideas into practice and to test their viability. Yeang's developing ideas on sun-shading , the double roof and 'filter' architecture are all examined here. Yeang sees building enclosures as environmental filters and interprets this idea into built form.

During **inception stage** Yeang searched for consultants inside Malaysia who were competent enough to understand the issues of *er design*. Along this search, Yeang tried to employ architects who were aware of the benefits of *er design* and understand his methodology. In a way, he started to organise his team for future projects.

Yeang's first priority on the Roof Roof House project was to implement his ideas on er. As Ken Yeang being the client himself, prepared his *brief* for the project. He organised the design team in his office and attended a *senior architect* to be in charge of the project.

During **preliminary stage**, design team collected information about the site, part of the design strategy (Table 3.1) . The site is located on a flat land near rubber plantation. The building will be effected from microclimate data. The rubber plantation prevents unwanted wind. There was no structure to obstruct the *orientation* of the building. The building is oriented to wind conditions on the site.
The angled configuration works together with the orientation of the building, a north-south orientation with the ground prevailing SE and NW *winds* (Figure 3.9). The

advantage is enhanced by enabling this to be cooled as it traverses over the pool water by evaporation before entering the living spaces (Figure 3.13) (Yeang 1994: p.12).

The idea of double roof became his first attempt for the development of the filter architecture (Figure 3.14). The outer roof formed by series of concrete beams that placed with spacing, work as a solar filter for the house (Yeang 1994, p.11). The design of the second roof with flying beams is angled and shaped over the building to reflect the solar radiation.

The moveable internal glass partitions and panels become the adjustable parts that can be manipulated to control the wind-flow and the internal microclimate (Figure 3.12). The living room at the ground floor opens to the outside shaded swimming pool (Figure 3.13). Yeang attempted to break down the distinction between inside and outside spaces, and the pool area is seen as an extension of the living space. A circular stairs reaches to the upper gallery space and later couple of steps down leads to the dining room (Figure 3.13). Form the dining room, there is an access to the kitchen area, then another door leads to the entrance hall an open passage with security grills placed at both ends provide cross ventilation (Figure 3.13).

The second floor consists of a gallery, a family space, the master bedroom suite and two bedrooms (Figure 3.12). A glass door from the family hall gives an access to a terrace that is the roof of the car-porch (Figure 3.14). The adjustment of the doors creates cross ventilation through the house. From this hall the stairs leading to the roof terrace which is kept cool by the sweeping filter pergola over the entire house (Figure 3.14).

The house is at the edge of the city and the desire for openness is confronted with a requirement for security and for the exclusion of mosquitoes and other 'wildlife' from the adjoining rubber estate. The openness of a Malay kampong house, it seems, is not possible in an urban situation and the need to install extensive security devices is the price to be paid for a low-technology solution. Air-conditioning is now essential in the bedrooms.

However, the Roof-Roof House is not without faults, and some of the 'valve' devices that Yeang has incorporated require considerable effort to balance (Powell 1999, p.119). The house was designed by Yeang when he was a bachelor. Now that he is married, and with children and domestic staff sharing the accommodation, some of the climatic control devices do not work as well as intended, for they have to cater the multiple activities of a family.

3.4.2 Menara Mesiniaga (1992), Subang Jaya, Malaysia

Menara Mesiniaga is a seminal building that integrates all of Yeang's previous research into the principles of the design of tall buildings in tropical climates. It is the first of what he terms the 'Series 2' towers. It declares the arrival of an original new type of skyscraper, the form which is derived from the application of *er design* principles.

IBM Mesiniaga Sdn. Bhd. wanted to have a prestigious building for company's future image and development. They needed office spaces and social activity areas in the building like pool fitness room and a restaurant. IBM commissioned Yeang to build a high-tech corporate showcase. Before the project started Ken Yeang made agreements on the design strategies with the client.

Ken Yeang persuaded the client to use passive systems in the building design by presenting his past projects performance. However, he added that he needed consultants for good performance of the building. IBM Mesiniaga Sdn. Bhd. accepted his request.

Yeang programmed Menara Mesiniaga in project stages. He continuously monitored the progress of the building, formed all necessary links between his office and site. Anything designed in the office was done with few alterations.

Table 3.2 Design strategies for Menara Mesiniaga (by Eray Bozkurt).

DESIGN STRAGIES FOR THE MENARA MESINIAGA	
SITE CONDITIONS	
Climate:	Tropical (see Figure 2.4). Microclimate conditions are important
Topography:	Urban land
Orientation	Orientation to the sun
Vegetation	Urban land
Wildlife	Urban land
Wind	Prevailing SE and NW winds
Sun	Tropical conditions
Humidity	High levels of humidity. Not considered during design process
Temperature	Tropical season. Temperature is constant all year around.
Precipitation	
BUILDING	
Building Envelope	Three fold structure that consists of a sloping landscaped base, a spiralling body with landscaped
	with landscaped sky-courts and external louvres and upper floor for recreational activities.
Shading	External louvres shades the offices. Planting provides shade in atriums.
Indoor Air Quality	Plantation for toxic gases. Access for air ventilation.
Material Selection	High-tech, steel and glass. Rusting caused on panels due to high humidity.
Thermal Mass	Curtain wall glazing is used on north and south facades to moderate solar gain.
Air Velocity	Standard office conditions.
Use Patterns	Standard office use patterns
Relative Humidity	No precautions.
Clothes and Appliances	
OPERATIONAL SYSTEMS AND SERVICES	
Heating	Tropical climate no heating is required.
Cooling	The atriums provide cool flow of ventilation throughout the building's transitional spaces.
Lighting	Natural and artificial lighting
Water conservation	**Balance of rain water returned to ground water**
LIFE-CYCLE MANAGEMENT	
Recycling	
Reuse	
Durability	
Waste	
Remanufacture	
Repair and Maintenance	

In the **preliminary studies**, research and analysis should be done over the site (Table 3.2). Research includes topography, orientation, sun path, vegetation, wildlife, wind directions and site microclimate. Yeang considered all these factors and decided the building configuration and the feasibility of the brief on the site.

Menara Mesiniaga has a threefold structure that consists of a sloping landscaped base, a spiralling body with landscaped sky-courts and external louvres that shade the offices, and an upper floor that houses recreational facilities, a swimming pool and a sun-roof. The structure of the building is exposed and the tubular-steel structure that crowns the tower is intended for the future installation of solar panels to further reduce energy consumption. Building automation systems (BAS), an active 'intelligent building' (IB) feature, are used in the building saving energy.

The most exciting design feature is the *vegetation* which is placed on the *facade* and the *skycourts* starting from a three storey high planted mound and spiralling up the face of the building (Figure 3.17). The atriums provide cool flow of *air ventilation* throughout the building's transitional spaces while the planting provides shade and an oxygen-rich atmosphere. Terraces are placed on all the office floors, and have full- height glass doors to control the natural ventilation. Lift lobbies, stairwells and toilets have natural ventilation and sunlight. All the window areas facing the east and west have aluminium fins and louvres to provide *sun-shading.*

The rooftop sun terrace is covered with a sunroof of trussed steel and aluminium (Figure 3.19) similar strategies used in his Roof-Roof House to shade and filter the light on the swimming pool and the curved gymnasium. Also creates a space for the possible future fixing of solar cells.

At **construction stage**, Yeang checked the general compliance with the designs of works being executed. He provided any instructions needed for the contractors to co-ordinate and correctly execute the works. Yeang's site architect monitored the construction work in accordance with the project timetable, applicable rules and standards and the contract documents with regard to building dimensions, quality standards, and appearance.

The facade of the building is designed to be an *er* 'sieve like' filter and not a 'hermetically sealed skin' (Figure 3.18) (Powell 1999, p. 47). Louvres of varying configuration relate to the orientation of the building to the sun and reduce solar gain. Deep insets in the facade permit the use of full-height clear glazed curtain walls on the north-and south-facing facades. The planar Corbusien image of Plaza Atrium and IBM Plaza is abandoned: Menara Mesiniaga looks distinctly high-tech, the external cladding being steel and glass curtain walling. Curtain wall glazing is used on the north and south facades to moderate **solar gain**. Glazing details allow the light-green glass to act as a ventilation filter, protecting the interior without totally insulating it. The placement of the core functions on the hottest(east) side of the tower contributes to the ecological sensibility.

The interstitial spaces in the Menara Mesiniaga high-rise tower are a dramatic improvement on Yeang's earlier projects (Figure 3.17). The landscaping of the sky courts and terraces is well established and receives regular maintenance. The idea of landscape spiralling up the outside of the tower and linking with the sloping base creates physical continuity and encourages species diversity. The sky-courts provide visual relief for the office worker and are used by some employees for brief respites from the stress of staring at a computer screen, though the numbers are disappointingly few. Perhaps others will come to recognise these benefits in time – the architect has provided the opportunity.

In 1995, **Menara Mesiniaga** received **Aga Khan's Awards for Architecture** [6]; the selection process is recorded in the book Architecture Beyond Architecture' by Charles Jencks, one of the members of the jury that awarded the prize, explaining the reason for the tower's selection, says:

[6] **The Aga Khan's Awards for Architecture:** The aim of scheme (had six three-years cycles) is to celebrate the work of people who have 'improved the physical environment of Muslims and those among whom they live. The awards are the only ones which are carefully given only after buildings have been in use for a while, so that premiated work has some chance of standing the test of time (Davey 1998, p 17-18).

> This striking interpretation of the corporate landmark skyscraper explores a new direction for an often pompous building type. Instead of a typically authoritarian and introverted statement of a multinational corporation, the tower is a robust, informal and open expression of emerging technology (Powell 1999, p.48).

The result, Jencks concludes, 'recalls the climatic architecture of the 1950s and Frank Lloyd Wright's skyscraper projects, in a move towards a new architecture for the 1990s. It is a striking alternative to the reigning mode of corporate towers and a new synthesis for contemporary architecture that is responsive to the climate of a particular place and finds inspiration for a new architectural language from forces that are ultimately cosmic (Powell 1999, p.48). Peter Eisenmann, another member of the jury, has no doubts about its relevance: ', he asserts:

> Menara Mesiniaga is one of the few projects that contributes new thinking to the general culture of architecture'. In 1996, underlining this critical acclaim, the building is awarded the International Architecture Award of the Royal Australian Institute of Architects (Powell 1999, p.48).

Menara Mesiniaga is not problem-free. Due to high levels of humidity, some rusting can be observed, and some of the insulation material on the underside of the roof has proven not to be durable in the Malaysia context. It points to the need for life-cycle costing of the materials used in skyscraper construction; in Yeang's later ecological agenda such information on the inputs and outputs of a building is accorded much greater priority (Powell 1999, p.48).

3.4.3 Permateelisa Technological Campus Project (1998) in San Vendemiano,Italy

The Permasteelisa Technological Campus project in San Vendemiano, Italy, is a test-bed for the application of experimental facades on high-rise buildings. A research programme has been set up to test the possible configurations of various facade systems. Yeang's proposal blends the existing Quaternario ABS facade

Table 3.3 Design strategies for Permateelisa Technological Campus (by Eray Bozkurt).

DESIGN STRAGIES FOR THE PERMATEELISA TECHNOLOGICAL CAMPUS	
SITE CONDITIONS	
Climate:	Mediterranean (see Figure 2.4).
Topography:	surrounded by existing buildings and plantation
Orientation	North and south sun orientation
Vegetation	Man-made plantation
Wildlife	Not considered
Wind	
Sun	Mediterranean conditions.
Humidity	Changes according to four seasons (Figure 3.x)
Temperature	Changes according to four seasons (Figure 3.x)
Precipitation	Changes according to four seasons (Figure 3.x)
BUILDING	
Building Envelope	Facade and interior design for an existing 3 storey building
Shading	Movable shading devices are used
Indoor Air Quality	Special plantation used to prevent toxic gases and dust
Material Selection	Existing brick and concrete building. New facade added to control the inside thermal comfort
Thermal Mass	New facade modifies all unwanted heat gains and wind.
Air Velocity	Calculated for one person occupation
Use Patterns	Calculated for computers', normal office activity, and meetings
Relative Humidity	New facade and interior plantation modifies humidity
Clothes and Appliances	Calculated for computers', normal office activity, and meetings
OPERATIONAL SYSTEMS AND SERVICES	
Heating	Mixed-mode system is used. Passive heating and active heating are used. Active heating is placed in the condition when passive heating isn't available or enough
Cooling	Passive cooling is used. No need for active cooling.
Lighting	Natural and generated artificial lighting
Water conservation	Rain water is collected at the roof and used for watering the plants in the new facade
LIFE-CYCLE MANAGEMENT	
Recycling	
Reuse	Existing building's structure
Durability	
Waste	
Remanufacture	
Repair and Maintenance	

concept with the innovative use of planting in a hybrid system. The hybrid facade incorporates a rainwater collection-and filtration device, a glazing system, planter-boxes with self-irrigation and hydroponics planting, and an external planted trellis. The design creates a thermal flue in summer and a thermal buffer in winter. Plants - are selected and incorporated precisely for their ability to provide shade, to remove

heat by transpiration, and to absorb toxins and microbes emitted from the building's occupants and equipment.

The technology developed in the Permasteelisa Technological Campus project will, if it proves successful in field trials, have several applications in the 'green skyscraper'. It could enable a breakthrough in the development of the interactive wall (Powell 1999, p.124).

In any ecosystem, Yeang writes:

> The climate is held to be the predominant influence even though other biotic factors such as flora and fauna and their interaction with the soils have an influence on the system. In most urban locations, all that remains of the site's ecosystem components is the upper geological strata, with a much simplified and reduced flora and fauna component. In any new built system, the fundamental ecological value of increasing the site's biological diversity should be recognised. Vertical landscaping in the skyscraper introduces organic matter into an otherwise high concentration of inorganic mass on a small site (Yeang1999, p.124).

Yeang notes that:

> Plants have aesthetic, ecological and energy-conservation benefits as well as providing effective climatic shields to sun., wind and rain. Planting can shade the internal spaces and the external wall, and can minimise external heat reflection and glare into the building. Plant evaporation processes can be effective cooling devices on the facade, affecting the facade's microclimate (Powell 1999, p.124).

The details of the project were arrived to the office through faxes that were sent by the client. The project was located in Italy, and we didn't have chance to have site visit. We had lack of information about the site. Even the drawings were sent not to scale. For design purpose, in the faxes there were facade system standard manual

prepared by environmental engineering company who would be in charge of the construction.

In the first meeting, Ken Yeang prepared the programme for the design process of the project. He advised to relate the design to existing site conditions. The lack of information still wouldn't effect us building according the site conditions. There were resources which could provide enough information of the site. First attempt on the project is to prepare a portfolio of our research on the site.

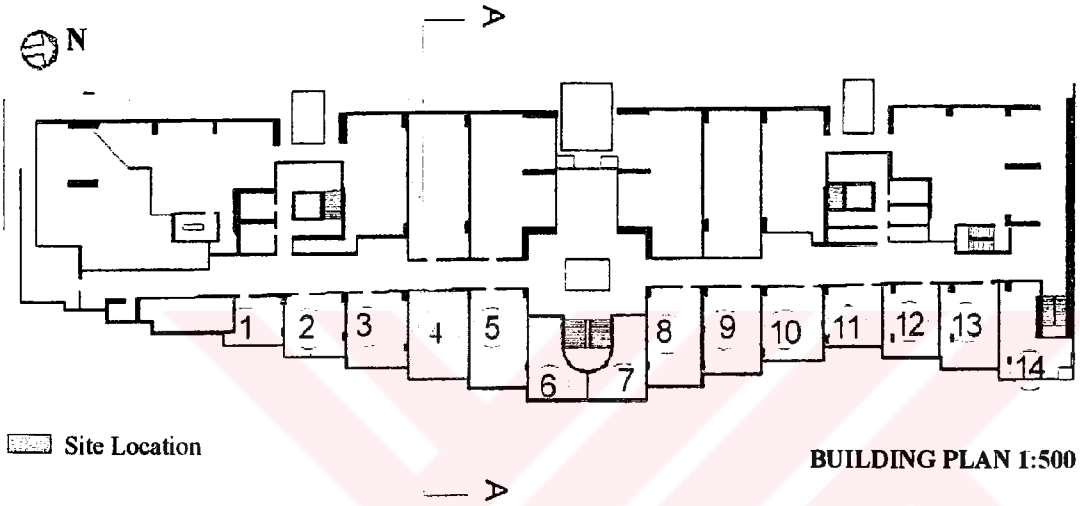


Figure 3.22 Existing Building's Plan scale: 1/500 (by Tr.Hamzah and Yeang's office)

In the **preliminary studies**, we investigated on the existing site conditions, surrounding buildings, and the vegetation (microclimate) around the building. For this purpose we found the macroclimate data for the region in terms of sunshine, cloud, temperature, wind, humidity and precipitation. Italy is located in the temperate climate. The sun path diagrams for the region on different season was important to calculate the distances that the sun can penetrate into the building, so that we could adjust the solar gain. Heat gains for different room uses like CAD room, conference/seminar room, and the administration offices calculated to prevent unwanted heat. The solar gain and the heat gain both have close effect on the thermal comfort of the occupant's in the space.

Sun path diagrams were obtained for the region to analyse the sun's directions throughout the year (Figure 3.23). This information helped to make decision on shading. If the option would be fixed shading, then its fixing position needed to be checked for better performance.

The design proposal utilise a passive, low-energy approach design which is bioclimatic approach. The main design feature proposed is the use of planting and vegetation as a crucial component of facades. The facade uses planting in three zones (Figure 3.26 to Figure 3.29):

Zone 1: using external planting as sun-shading passive
Zone 2: using planting as acclimatisation and thermal buffer passive
Zone 3: using indoor planting for air purification active.

The passive environmental control system works with an active heating and cooling system. Mechanical and electrical systems to regulate the internal temperature to a comfortable level throughout the year. The passive system helps to reduce the energy consumption of the active system and as much enhance the energy efficiency of the building. This leads to a lower energy consumption building as part of a 'green' architectural philosophy.

After all these information collected, in the **basic project,** Ken asked each member of the team to prepare couple of design options. This way the design alternatives would be increased. Later, everyone came up couple of **sketch studies** considering the site conditions and uses patterns for the space. In time, the purpose of the room might change and this has close effect on the heat gain and air velocity of the space which could effect the thermal comfort. Any misinterpretation would cause add on systems for cooling like air conditioning. As the space wanted to behave well for climatic changes and occupants' well being. Indoor air quality is important criteria for the design and measures taken to provide . Every design criteria eventually help to reduce the energy consumption.

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DOKÜMANTASYON MERKEZİ

The optimal use of natural daylight replaced the artificial light use, brought energy efficiency and visual comfort. All the design strategies are adopted to meet occupants needs. The main design feature for the building, which is the use of planting and **vegetation** as a crucial component. The microbes, protozoa in soil and plant leaves help in absorption and removal of emitted toxins. The building uses planting in three zones.. Ventilation outlets designed for unwanted hot air to be expelled and replaced by fresh air.

Design team agreed that external planter boxes should be placed on the facade for **shading**. During summer, plants from the planter boxes will hang down and act as sun-shading devices. There will be rainwater collection and filtration device to re-circulate rainwater for use in tubular mullion system to water the plants. No additional water is needed. In winter, plants will drop their leaves for maximum sun penetration and consequently building will be exposed to maximum solar gain.

3.5 YEANG'S FUTURE PLANS FOR HIS DESIGN AGENDA

In Yeang's book Bioclimatic Skyscrapers(1994), Yeang defined his future aspects , which are the beneficial use of wind and rain, the life-cycle approach to the use of materials and building equipment, and the development of new patterns of internal life for the users (Yeang 1994, p.23). Following the wind-related design explorations, he stated that his future work will continue with research on other climatic factors affecting building design both sculpturally and systematically. The strategies included were looking for the possible uses of rainwater and water-spray walls that induce evaporative cooling. Conservation of sites with ground level filter beds, reintroducing rain to the land form instead of wasting it to drainage systems, is also under focus. For cladding and skin, materials research, taking account of life-cycle and time. For instance, structure is seen as long-life while cladding is short-life, recyclable and subject to refit and remodel pressures. Both energy performance and image can be upgraded as materials develop and occupancy change.

Prof. Dr. Ken Yeang's future agenda will involve more research, design and development work into other environmentally aspects on building design. Yeang, in his future design agenda, will concentrate more on the life-cycle management strategies.

CHAPTER 4

CONCLUSION

Er design has often been mistakenly viewed as a fashionable stylistic movement. However, it is actually a process of making vital decisions to create healthy, comfortable buildings in harmony with the natural environment and man.

This thesis underlines the importance of the role of architects who play a central role in ensuring a sustainable future (Yeang 1999, p.286). Architects role is important that even simple decisions during the traditional project stages can prevent environmental problems and provide less energy use.

It's not common for many architects to apply *er design* method in their designs. One reason is the misunderstanding about the benefits of the method. It's true that there are still facts that need to be tested as we are still in the early days of *er design* (Yeang 1999, p.284). Architects are responsible for the creation of the buildings, eventually they need to increase their knowledge on *er design* to reduce the negative impacts of human constructions on the natural environment. It would be more beneficial if they imply *er design* into their design evolutions.

The methodology employed in this study attempts to assert that the knowledge gathered through 'research by design' that is, research carried out during the professional practices of architecture, is as vital as the knowledge gained through theoretical and analytical studies by the academic

It is often the case that, clients, being the financiers of the built environment, focus on immediate costs as their primary concern without assessing deeper what the occupants might physically desire. Some people assume that the actions implied by the act of being conscious of environmental issues are inadequate to influence the architectural community. It has to be admitted that changing one inefficient light bulb to a fluorescent one could not 'save the planet', though what people fail to see is that the majority of the decisions they make in their lives *do* have a direct effect on the natural environment.

Before industrial revolution, the buildings continued to be designed in passive methods in harmony with the natural environment. Since the development of mechanical means of controlling the internal environment of buildings, this connection between buildings and their context has been broken down. As a result current environmental degradation is created. Still there is a common belief that the nature can still recycle the emissions caused by the built environment and fossil energies will be enough for the future generations. However, it now commonly agreed among scientists that the extent of emissions of CO2 and other greenhouse gases will inevitably lead to climate change (Edwards 1998, p.25).

Perceiving sustainability on every scale, our powers to 'save the planet' become a reality. Although the ways in which the collective perception of sustainability could be spread globally is not the focus of this thesis, I have nevertheless examined the issue very briefly in the first chapter.

The understanding of sustainability as such possesses social, and rather political, implications. The perception of the actions of self in conforming relationship to society requires the existence of particular schools of thought. These might, initially, appear as irrelevant from a practical architectural point of view.

The thesis has neither the intention nor the scale to scientifically evaluate global consciousness of the natural environment, in relationship to architecture at large. One could argue, though, that it is precisely this perception which will take part in shaping the built environments of the future. The more aware people are of the

benefits of sustainability and *er design*, in both short and long term, the more they will demand from the architects and others who shape their built environments.

Ultimately, *er design* considers both the health of the planet and the well-being of the individual. The similarity in terms of scale to the idea of sustainability renders it a quite relevant and important issue in the architectural discourse, both within academic institutions and the professional scene.

The immediate question is what's going to be next? It's clear that conventional methods cause environmental and energy problems. Existing buildings may be modified to be more environmentally friendly and demolish the ones that causing serious emissions. However demolition is not the answer, as presumably new buildings that are built over the demolished ones, would have to be built to replace, even if very green, still going to be a net increase in use of resources and energy. When the emissions are lowered to certain level, the natural environment will clean itself with the help of biocycle.

The future of *er design* is dependent on education, public attendance, theory and practical results. It is not just possible to control the built environment solely with rules or regulations. Public knowledge and awareness of the issues are vitally important. Although architects all over the world, such as Yeang who are leading the way, they cannot make significant impact acting alone, without the support of clients and the general public.

Ken Yeang, continuing to push the limits for *er design*. His experiences are valuable, that need to be discussed in the architectural field. In Yeang's book, ~~The Green Skyscraper(1999)~~ and Kenneth Powell's ~~Rethinking the Skyscraper(1999)~~, prove Yeang's continuous efforts to update his theoretical ideas and building designs. Every building that are completed are research tools that he combines with new theoretical ideas for the success of next building. All Yeang's buildings are scientific experiences for future developments. Every observation is recorded especially the mistakes occurred after the building completed that somehow open new dimensions in the development of *er design* methodology.

Education is the key to creating common attitude in the public towards environmental sensibilities. The regulations and government rules are necessary, but it is not enough without public support. From the primary school, students should be acknowledged about the environmental ends. The society then begins to give importance for natural environment, and they would demand for the buildings constructed with *er design*.

The benefits of teaching environmental ends from primary school will be seen in the future. For today's conditions, architectural schools should equip their students with the essential knowledge for *er design*. There are courses in the universities of school of architectures which teach architecture students with *er design* issues. They need opportunity provided by public to imply their knowledge into physical reality.

Conferences and proceedings are important organisations where new findings can be discussed between the professions. There will be 22nd UIA Congress taking place in Istanbul, in 2005, can be an opportunity for Turkey to built *er designed* buildings, represent the country's attitude towards the environmental and energy issues. The results of these projects can be presented during the congress as future generations of buildings in Turkish architecture. From UIA 2005 Istanbul congress, encouraging consequences may be achieved for future of Turkey's built environment.

APPENDIX A

Since its creation in 1948, the UIA has organised 20 Congresses in different places and on specific themes:

1st	1948	LAUSANNE	Architecture Faced with its New Tasks
2nd	1951	RABAT	How Architecture is Dealing with its New Tasks
3rd	1953	LISBON	Architecture at the Crossroads
4th	1955	THE HAGUE	Architecture and the Evolutions of Building
5th	1958	MOSCOW	Construction and Reconstruction
6th	1961	LONDON	New Techniques and New Materials
7th	1963	HAVANA	Architecture in Underdeveloped Countries
8th	1965	PARIS	The Training of Architects
9th	1967	PRAGUE	Architecture and the Human Milieu
10th	1969	BUENOS AIRES	Architecture as a Social Factor
11th	1972	VARNA	Architecture and Leisure
12th	1975	MADRID	Creativity and Technology
13th	1978	MEXICO CITY	Architecture and National Development
14th	1981	WARSAW	Architecture, Man, Environment
15th	1985	CAIRO	Present and Future Missions of the Architect
16th	1987	BRIGHTON	Shelter and Cities - Building Tomorrow's World
17th	1990	MONTREAL	Cultures and Technologies
18th	1993	CHICAGO	Architecture at the Crossroads - Designing for a Sustainable Future
19th	1996	BARCELONA96	Present and Futures. Architecture in Cities
20th	1999	BEIJING 99	Architecture of the 21st Century

FORTHCOMING CONGRESSES

21st	**2002**	**BERLIN**	**Architecture as a Resource**
22nd	**2005**	**ISTANBUL**	

Source: http://www.uia-architectes.org/texte/england/2y1.html

APPENDIX B

20th UIA Congress Beijing, China

' The challenges for the 21st century face such as;

- What do we learn from Nature's revenge so far?
- Can the cities, and the ideas about cities, survive overwhelming urbanisation?
- How do we benefit from technology, whilst keeping its harmful effects at bay?
- How do we brink back the souls of cities and towns which were cherished by inhabitants and visitors in past centuries?

Over the centuries the role of an architect is constantly modified to suit its time. Effective designs emerge from a thorough understanding of the forces which shape our built environment. Architecture must extend its boundaries and concepts, bringing together specialist knowledge and expertise.

The members of the congress agreed on certain key points that the coming century calls for:

- **there should be a methodology that guides the architect through all aspects of the built environment;**
- **an architectural process which views construction, operation, maintenance, renewal conservation as a whole;**
- multiple technologies that are rooted in indigenous cultures and societies, and are extended to the realm of human feelings;
- regional initiatives that enhance visual and psychological identities;
- incorporation of fine art, craftsmanship and industrial design in architect's work;
- moral conduct that treats society as the ultimate client;
- **an open and continuous education programme for professionals, clients, and the wider public.**

APPENDIX C

UIA/AIA World Congress of Architects
Chicago, 18-21 June 1993

In recognition that:

A sustainable society restores, preserves, and enhances nature and culture for the benefit of all life, present and future; a diverse and healthy environment is intrinsically valuable and essential to a healthy society; today's society is seriously degrading environment and is not sustainable.

We are ecologically interdependent with the whole natural environment; we are socially, culturally, and economically interdependent with all of humanity; sustainability, in the context of this interdependence, requires partnership, equity, and balance among all parties.

Buildings and the built environment play a major role in the human impact on the natural environment and on the quality of life; sustainable design integrates consideration of resource and energy efficiency, healthy buildings and materials, ecologically and socially sensitive land-use and an aesthetic sensitivity that inspires, affirms, and ennobles; sustainable design can significantly reduce adverse human impacts on the natural environment while simultaneously improving quality of life and economic well being.

We commit ourselves, as members of the world's architectural and building design professions, individually and through our professional organisations, to:

- Place environmental and social sustainability at the core of our practices and professional responsibilities
- Develop and continually improve practices, procedures, products, curricula, services, and standards that will enable the implementation of sustainable design.

- Educate our fellow professionals, the building industry, clients, students, and the general public about the critical importance and substantial opportunities of sustainable design.
- Establish policies, regulations and practices in government and business that ensure sustainable design becomes normal practice.
- Bring all existing and future elements of the built environment – in their design, production, use, and eventual reuse – up to sustainable design standards

Olufemi Majekodunini
President
International Union of Architects

Susan A. Maxman
President
American Institute of Architects

Source: Ozkeresteci, Izzet (1998), Critical Evaluation of Architecture From the Ecological Perspective and Ecological Strategies for Architectural Design, METU, Ankara.

APPENDIX D

Hannover Principles:

1. Insist on the right of humanity and nature to co-exist in a healthy, supportive, diverse, and sustainable condition.
2. Recognise Interdependence. The elements of human design interact with and depend on the natural world, with broad and diverse implications at every scale. Expand design considerations to recognising even distant effects.
3. Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry, and trade in terms of existing and evolving connections between spiritual and material consciousness.
4. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems, and their right to co-exist.
5. Create safe objects to long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creations of products, processes, or standards.
6. Eliminate the concept of waste. Evaluate and optimise the full life-cycle of products and processes, to approach the state of natural systems in which there is no waste.
7. Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.
8. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled.
9. Seek constant improvements by sharing knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers, and users to link long-term sustainable considerations with ethical responsibility, and reestablish the integral relationship between natural processes and human activity.

APPENDIX E

Pursuant to article 1 of the Convention signed in Paris on 14th December, 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The Signatories of the Convention on the OECD are Austria, Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, **Turkey**, the United Kingdom and the United States. The following countries acceded subsequently to this Convention (the dates are those on which the instruments of accession were deposited): Japan (28th April 1964), Finland (28th January, 1969), Australia (7th June 1971) and New Zealand (29th May, 1973).

The Socialist Federal Republic of Yugoslavia takes part in certain work of OECD (agreement of 28th October, 1961).

APPENDIX F

International milestones of environmental agreement or awareness:

1972 'The Limits to Growth' Report

1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters.

1972 Stockholm Conference on the Human Environment (UN).

1973 Washington Convention on International Trade in Endangered Species.

1976 Barcelona Convention for the Protection of the Mediterrian Sea Against Pollution.

1978 Protocol to the 1973 International Convention for the Prevention of Pollution from Ships.

1979 Berne Convention on Habitat Protection (Council of Europe).

1979 Geneva Convention on Air Pollution (UN).

1980 Convention on the Conservation of Antarctic Marine Living Resources.

1980 World Conservation Strategy (IUCN).

1980 Global 2000 Report (USA).

1983 International Tropical Timber Agreement.

1983 Helsinki Protocol on Air Quality (UN).

1983 World Commission on Environment and Development (UN).

1987 Montreal Protocol on Substances that deplate the Ozon Layer (UN).

1987 Our Common Future (Brundtland Commission on behalf of the UN).

1988 The Intergovernment Panel on Climate Change.

1988 Toronto Conference on the Changing Atmosphere: Implications for Global Security

1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

1990 Green Paper on the Urban Environment (EC).

1991 Second Session of the Intergovernment Negotiating Committee for a Framework Convention Climate Change.

1992 Convention on Biological Diversity

1992 Framework Convention on Climate Change.

1992 Rio Summit Agreements (UN).

1992 Our Common Inheritance (UK).

1994 European Environment Agency established (EU).

1997 Kyoto Conference on Global Warming.

Sources: 1.Edwards, Brian. Sustainable Architecture. 2nd ed. London : Architectural Press, 1999, p.xiii.

2. Chasek, Pamela S., From Stockholm to Rio: An Analysis of 20 years of Multilateral Environmental Negotiation In The United Nations System, USA: A Bell & Howell Company, 1996, p.45.

APPENDIX G

The Architects' Directive:

1. An ability to create architectural design that satisfy both aesthetic and technical requirements.
2. An adequate knowledge of history and theories of architecture and the related arts, technologies and human sciences.
3. A knowledge of fine arts as an influence on the quality of architectural design
4. An adequate knowledge of urban design, planning and the skills involved in the planning process.
5. An understanding of the relationship between people and of the need to relate buildings and the spaces between them to human needs and scale.
6. An understanding of the profession of architecture and the role of architects in society, in particular preparing briefs that take account of social factors.
7. An understanding of the methods of investigation and preparation of brief for a design project.
8. An understanding of the structural design, constructional and engineering problems associated with building design.
9. An adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against climate.
10. The necessary design skills to meet building users' requirements within the constraints imposed by cost factors and building regulations.
11. An adequate knowledge of the industries, organisations, regulations and procedures involved in designing concepts into buildings and integrating plans into overall planning.

Source: Edwards, Brian. Sustainable Architecture. 2nd ed. London : Architectural Press, 1999, p 37.

APPENDIX H

The XXI Congress of the International Union of Architects, jointly organized by the UIA and the Bund Deutscher Architekten (BDA), will be held in Berlin (Germany), on 22-26 July 2002. The Union's General Assembly will be held in Berlin, on 27-29 July 2002.

Pre and post congress architectural events will be also organized in Berlin and in various german cities on 19-22 July and on 27-29 July 2002. During this period, congress participants can travel to Essen, Frankfurt, Hanover, Leipzig, Lübeck, Munich and Rostock, where architectural excursions and cultural events will be organized.

Through this programme, congress organizers wished to highlight the local features which are particular to the German Federal structure, and to show the architectural and urban works achieved in these cities, in connection with the congress theme.

ARCHITECTURE AS A RESOURCE

Professor Matthias Sauerbruch, together with the Congress Scientific Committee under his supervision, will be responsible for the orientation of the debates and works performed on the overall theme *"Architecture as a Resource"*. He will draw up the final report.

Both words *"Architecture "* and *"Resource"* have several meanings: architecture, art of edifying and purifying, building and preserving, as opposed to consumption and waste of energy and resources. Our planet, the world we leave in, is a closed system based on cycles and a self-regenerating process, which is integrated in a transformation and recycling process. Awarness of the cycles of materials, the balance of energy and resource limits will be decisive for this century's architecture and town planning.

This theme does not only refer to new forms of architecture resulting from a favourable environmental context, or to construction systems based on the use of soft energies. It also refers to the architecture of the past, conveying to it a new thematical impulse, as a cultural and material resource, while preserving its historical value. The conversion and re-use of urban structures and existing buildings will be subject to a growing development regardless to new construction projects. One of the most important tasks for the future is to enable city centres to recover their various functions, and rehabilitate anonymous suburbs through architectural and urban projects carefully designed.

In addition, the right for the homeless to live and to be decently housed should be defended and adequate architectural solutions should be provided in the field of housing, based on existing resources. It is also essential to consider, evaluate and structure the exponential growth of humanity through a clever use of recyclable resources.

Architecture is not a matter of façade, external elements or appearance, it is the implementation of structure, the expression of a content and meaning.

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With regard to this, the theme *"Architecture as a Resource"* includes the following issues:

- Permanent conversion of the city and society;
- New urban context according to economic, ecological, social and cultural changes;
- Re-use of restored old buildings;
- New buildings within the current urban context;
- Modernization of old buildings and preservation of historical monuments;
- Innovating technologies applied to building and sound use of resource;
- Cyclical economies and cost evaluation;
- Global approach and interdisciplinary collaboration;
- Changes in architectural education system according to new requirements;
- Long-term evolution on the definition of professional practice.

A CONGRESS OPEN TO ALL THE PROFESSIONALS OF THE BUILT ENVIRONMENT

The congress theme and its developments are meant for a large public consisting of:

- Architects, interior architects, landscape planners and town planners;
- Engineers, planners, projects developers;
- Equipment managers, property consultants, syndic and building contractors;
- Politicians and decision-makers;
- Client representatives, investors, builders of housing units;
- Banks and construction companies;
- Contracting authorities and users;
- Construction companies, craftsmen and material manufacturers;
- Teachers, scientists and students;
- Cultural institutions and media.

Various meetings of the professionals of the built environment will be held simultaneously with conferences on the themes:

- International Forum of Architectural Critic;
- International Trade Forum;
- International Conference of Investors;
- International Building Forum;
- International Architecture Film Festival;
- Construction Companies Day;
- Professional Fair on Planning and Construction;
- Meeting on export-related activities on the theme "Planning, Building, Management";
- Banks Forum on the financing of construction projects.

PROGRAMME

Mornings, there will be plenary sessions, led by internationally renowned architects. Afternoons, forums on specific aspects of the thematic topic will be developed with the contribution of experts from the five Regions of UIA, its Member Sections and Work Programmes representatives.

Two Soirées are scheduled: one dedicated to the international confrontation of projects by students of architecture, one to 2002 Gold Medal and UIA Prizes, after the opening ceremony. An architectural parade will be organized in the city of Berlin to bring together congress participants and the inhabitants of the city.

Exhibitions, workshops, competitions and a rich cultural programme will also be proposed to congress participants. More details on this programme will be published later.

ITINERARIES: ARCHITECTURE AND THE CITY IN GERMANY

- Architectural visits in Berlin
  During the congress, German architects will guide groups of about fifty congress participants from the congress centre towards their built architectural work in Berlin. These thematic visits include: 1920s residential buildings; government buildings; restorations, etc.

- A city, a motto.
  The week end following the congress, participants can make one-day excursions, departing from Berlin, in cities selected for their architectural and urban features:
  - "Parc City" (ParkStadt): Cottbus-Branitz-IBA
  - "Bauhaus 1": Dessau
  - "Bauhaus 2": Weimar
  - "Elb Florence" (Elbflorenz): Dresden
  - "The City of Art" (Kunststadt): Kassel
  - "The City of Automobile"(Autostadt): Wolfsburg (Wolkswagen)
  - "Shinkel/Fontane": Potsdam, Rheinsberg, Neuruppin.

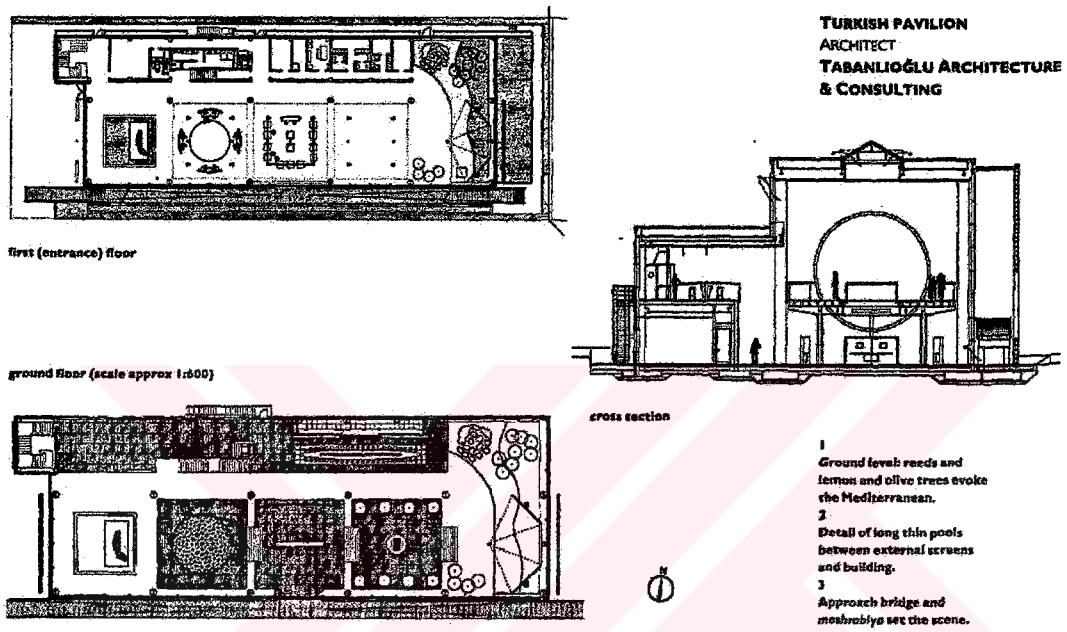
- The faces of Germany through its cities.
  Four-day tours will be proposed to congress participants wishing to make an architectural excursion before they travel back to their home country:
  - The Ruhr area, Düsseldorf, Cologne
  - Frankfurt (on the Main), Nuremberg, Munich
  - Stettin, Frankfurt (on the Oder), Warsaw
  - Dresden, Prague (Czech Republic).

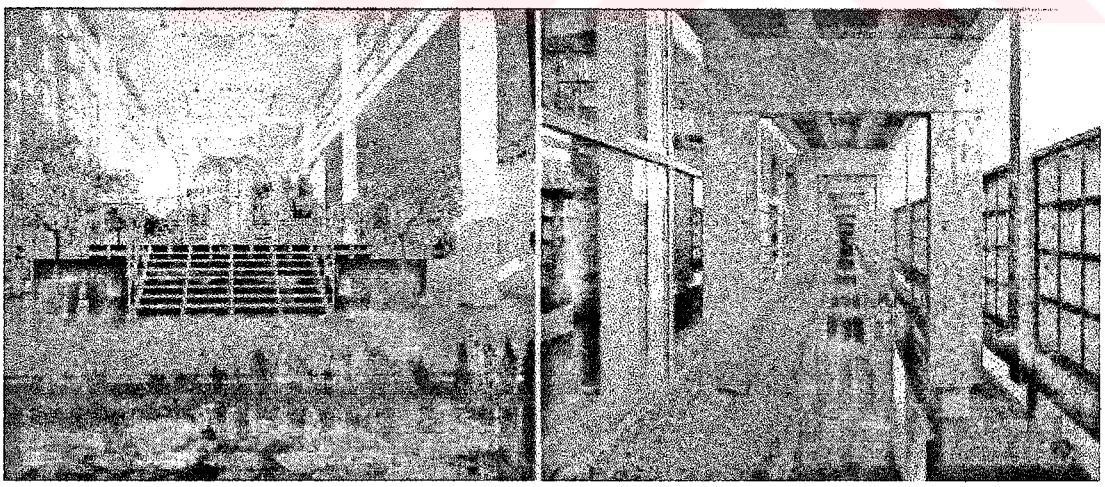
- Information:
  UIA Berlin 2002 e.V.
  Bund Deutscher Architekten-BDA
  Köpenicker Strasse 48/49
  D-10179 Berlin (Mitte)
  T. (49.30) 27 87 99 0 - F. 27 87 99 15
  E-mail : info@uia-berlin2002.com
  Site web : www.uia-berlin2002.com

Source: http://www.uia-architectes.org/texte/news/2berlin2002.htm

APPENDIX I

Turkish Pavilion, Expo 2000.





Source: Architectural Review September 2000, p 76 and 77.

APPENDIX J

Third Clean Energy Symposium (15-17 November 2000,Istanbul):





OTURUM BAŞKANLARI

ÖNDER DEMİRER
(Demirer Holding)
Doç. Dr. ALİ UYUMAZ
(İTÜ)

11:00–11:15
Developing a Wind Farm Project in Turkey
HARRY MALYON (National Wind Power)

11:15–11:30
Hız Süreklilik Eğrilerinin Rüzgâr Verilerine Uygulanması
KASIM KOÇAK (İTÜ)

11:30–11:45
İzmir'de Yapılan Dört Yıllık Rüzgâr Ölçümlerine Dayanan Bir Enerji Değerlendirmesi
AYDOĞAN ÖZDAMAR (Ege Ün.)

11:45–12:00
Akhisar Rüzgâr Elektrik Santrali için Rüzgâr Türbini Mikrokonuşlandırması
MURAT DURAK (AK–EN AŞ)

12:00–12:15
Solar and Wind Energy Applications of Power Electronics
AHMET AFŞİN KULAKSIZ (Selçuk Ün.)

12:15–12:30
Rüzgâr Hızı Yükseklik Değişimi Formülasyonu
ÇAĞLA BALCI (NTV)

OTURUM BAŞKANLARI

Prof. Dr. SADRİYE KÜÇÜKBAYRAK – OSKAY
(İTÜ)
Prof. Dr. VİLDAN OK
(İTÜ)

11:00–11:15
Enerji ve Yapı Yüzeyi İlişkisi
SEMİH ERYILDIZ (Anadolu Ün.)

11:15–11:30
Enerji Korunumlu Binalarda Dış Duvar Kuruluşları
TÜRKAN GÖKSAL (Anadolu Ün.)

11:30–11:45
Güneş Enerjisine Uyumlu Bina Tasarımları,
–Güneşbacalı Bina Yapımları–
HÜSEYİN ÖZDEN (Afyon Kocatepe Ün.)

11:45–11:00
İzmit Birleşmiş Milletler Çadır–Kenti Güneş Evi ve Bilim Oyunları Merkezi
ENGİN KIRAN (TEMEV)

12:00–12:15
Anadolu Güneş Mimarlığı
DEMET IRKLI ERYILDIZ (Gazi Ün.)

12:15–12:30
Türkiye'nin İlk Ticarî Ekolojik Konut Projesi
ÇELİK ERENGEZGİN (Çaba Tasarım Ltd.)





OTURUM BAŞKANLARI

Prof. Dr. NİLÜFER EĞRİCAN
(İTÜ)
OSMAN İLHAN
(ETKB)

16:00–16:15
Güneş Enerjili Kereste Kurutma ve Çevre Kirliliğin Önlenmesine Katkıları
KEMAL ÜÇÜNCÜ (KTÜ)

16:15–16:30
Isı Pompalı Kurutucularla Emisyonların Azaltılması
ALP AKIN (EÜ)

16:30–16:45
Ortam Havasının Isıtılmasında Yeni Bir Yöntem: Güneş Duvarı
HALUK SAYAR (Alternatif Enerji Ltd.)

16:45–17:00
Isıtma–Soğutma Sistemleri Tasarımında Meteorolojik Değerlerin İstanbul İçin Hesaplanması
HÜSEYİN TOROS (İTÜ)

17:00–17:15
Güneş Enerjisinden Edilgen Sistemle Yararlanan Okul Yapısı Örnekleri
GÜLAY ZORER GEDİK (YTÜ)

17:15–17:30
Çift Akışlı ve Daralan Genişleyen Kanallar İçeren Bir Hava Isıtıcılı Güneş Kollektörü Performansının Deneysel Olarak Araştırılması
MEHMET ESEN (Fırat Ün.)

OTURUM BAŞKANLARI

Prof. Dr. SERVET ARMAĞAN
(İÜ)
SELÇUK KARADELİ
(ETKB)

16:00–16:15
Rüzgâr Enerjisinin Tarımda Kullanımı
MURAT DURAK (AK–EN AŞ)

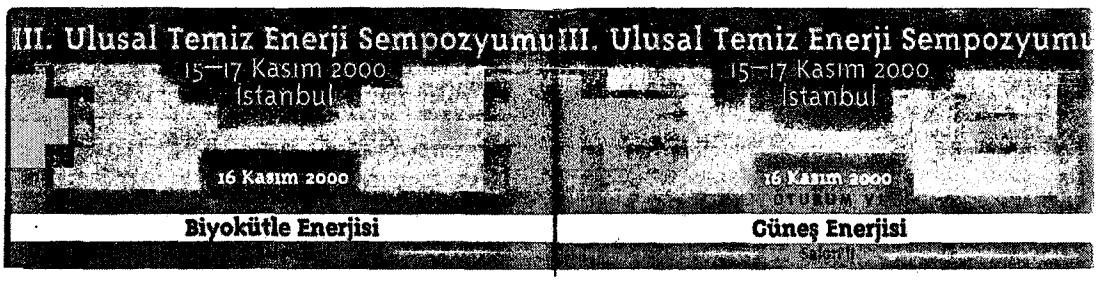
16:15–16:30
Rüzgâr Türbiniyle Sürülen Senkron Generatörün Çıkış Büyüklüklerinin Bulanık Mantıkla Kontrolü ve Simülasyonu
YÜKSEL OĞUZ (MÜ)

16:30–16:45
Optimal Design of a Composite Rotor for Wind Turbine
ÖMER SOYKASAP (Afyon Kocatepe Ün.)

16:45–17:00
Yenilebilir Enerji Kaynaklarla Elektrik Santralleri
CİHANGİR PEHLİVAN (Umwelt Alternatif Enerji AŞ)

17:00–17:15
Rüzgâr ve Güneş Enerjisinde Elektrik Üretimi ve Türkiye İçin Önemi
ATEŞ UĞUREL (TERA Enerji AŞ)

17:15–17:30
İstanbul Çevre Merkezi
ÇELİK ERENGEZGİN (ÇABA Tasarım Ltd.)



Biyokütle Enerjisi

OTURUM BAŞKANLARI

Yard.Doç. Dr. ŞEVGİ ŞENSÖZ
(OGÜ)
Dr. UMRAN SERPEN
(İTÜ)

14:00–14:15
Biyokütle Enerjisinin 21. Yüzyılda Dünya ve Türkiye İçin Önemi
NEDİM SARAÇOĞLU (Zonguldak Karaelmas Ün.)

14:15–14:30
Biyokütleden Enerji Üretiminin Ekonomik Analizi
ENGİN TÜRE (Mimar Sinan Ün.)

14:30–14:45
Kızılçam (Pinus Brutia Ten.) Odun Talaşının Sabit Yatak Reaktöründe Pirolizi
DİLEK ANGIN (Osman Gazi Ün.)

14:45–15:00
Biyokütle Enerjisine Bir Örnek: Anaerobik Yöntemlerle Organik Atıklardan Biyogaz Eldesi
GÖKSEL DEMİRER (ODTÜ)

15:00–15:15
Orhaneli Lintiyine %5 Biyokütle İlavesinin SO_2 Emisyonuna Etkisi
HANDAN ÇUBUK (YTÜ)

Güneş Enerjisi

OTURUM BAŞKANLARI

Prof. Dr. ABDURRAHMAN KILIÇ
(İTÜ)
Doç. Dr. AYNUR ERAY
(HÜ)

14:00–14:15
Türkiye Güneş Enerjisi Potansiyeli
ELÇİN TAN (İTÜ)

14:15–14:30
Güneş Enerjisinin Foto–Optik Sistemle Toplanıp İletilerek Foto–Termik Olarak Elektrik Üretilmesi
MEHMET ALİ ÇINAR (Adana)

14:30–14:45
Erciyes Üniversitesi'nde Güneş Enerjisi Uygulamaları ve Örnek Çalışmalar
NECDET ALTUNTOP (Erciyes Ün.)

14:45–15:00
Güneş Enerjisinin Yeraltında Depolanması ve Isı Pompası Desteğinde Konutların Isıtılması
RECEP YUMRUTAŞ (Gaziantep Ün.)

15:00–15:15
Rüzgâr ve Güneş Işını Enerjilerinin Birbirini Tamamlaması: İzmir Örneği
AYDOĞAN ÖZDAMAR (EÜ)

15:15–15:30
Fotovoltaik Enerji ile Soğutma
MEHMET BEKLERGÜL (EÜ)

Source: Third Clean Energy Symposium's leaflet.

APPENDIX K

FOUR SEASONS SUNROOMS
SUNROOMS • CONSERVATORIES • PATIO ROOMS
GLASS AND SCREEN ENCLOSURES • SKYLIGHTS
Outdoor Living...Indoors™
FOUR SEASONS SOLAR PRODUCTS CORP.

5005 Veterans Memorial Highway, Holbrook, New York 11741
Tel (516) 563-4000 • Fax (516) 563-4010
1-800-FOUR-SEASONS (1-800-368-7732)
Internet http://www.four-seasons-sunrooms.com
E-Mail info@four-seasons-sunrooms.com

August 24, 2000

Eray Bozkurt

Dear Eray Bozkurt

Thank you for inquiring about Four Seasons Solar Products Insulated Glass Photovoltaic Sunrooms Following is the additional information you requested.

Four Seasons Solar Products Corp. is the largest and most well regarded sunroom manufacturer in the United States and in the world. Internationally recognized for being on the cutting edge of sunroom and glass technologies, Four Seasons keeps its edge over the competition by using only the latest, time-tested and proven technologies (i.e. thermally broken aluminum extrusions and proprietary, exclusive, super insulated, high performance MC Wonderglass™) as well as by offering a top quality installation and superior service.

Four Seasons, along with Siemens Solar Industries (the world's largest producer of PV modules) has developed a unique PV solar module designed to replace roof glass sections of Four Seasons Sunrooms. The special design of this module incorporates Siemens Solar's high efficiency PowerMax® Solar Cells laminated between two pieces of tempered safety glass and then manufactured by Four Seasons into an insulated glass unit with Four Seasons Sunrooms exclusive MC Wonderglass™ as the inside light. The cells in the lamination are arranged with clear space around each cell to allow approximately 35 percent of the available light to enter the sunroom, while still collecting the most PV energy. This revolutionary design results in maximum Photovoltaic power being collected, while filtered sunlight enters the room like dappled sunlight through the leaves of a towering oak tree. This unique design makes PV power aesthetically, as well as environmentally, attractive.

The panels are currently available in Four Seasons Sunrooms most popular glass sizes, a 30" x 31 1/8" 36-cell, 55- watt panel and a 36" x 31 1/8" 42-cell, 64-watt panel.

For pricing** and ordering information, call Don Staib, Director of Four Seasons Sunrooms Custom and Commercial Division, at 800-533-0887, extension 265.

*** Qualifying residential installations in New York State are eligible for deep discounts due to funding awarded to Four Seasons Solar Products by the New York State Energy Research and Development Authority.*

Siemens Solar and Four Seasons Solar jointly develop a unique integrated solar panel.

Siemens Solar is the world's largest manufacturer of Photovoltaic (PV) cells and modules. Together with Siemens, Four Seasons has designed a very special kind of solar module. By arranging the solar cells with space around them, the new PV module lets in 25 to 35% of available light. This arrangement is then manufactured into an insulated glass panel with MC WonderGlass™ as the inside light. The result, as you can see from the photos, is a pleasing "screen" effect that lets in light, yet collects maximum electricity, thanks to Siemens high efficiency Power Max™ solar cells. Nobody else has it, nobody else does it better!

Typically the solar modules will replace the opportunist rows of glass. The unique shadow effect (see photos below) actually enhances the look of the sunroom. And it's nice to know anytime you look up at your photovoltaic system, that you are doing something positive for the environment, collecting free solar generated energy to replace environmentally polluting fossil fuel generated energy. At this time, two solar modules are available, in our two most popular glass sizes:

(1.) A 55-watt, 36 cell module 30" x 31 1/8" and
(2.) A 64-watt, 42 cell module 36" x 31 3/4"

Appropriate pure sine wave inverters are also available for grid connected systems. The inverter converts photovoltaic DC into 60 cycle alternating current.

FOUR SEASONS OFFERS YOU TWO WAYS TO "POWER UP"!

(#1.) NET METERING:



Utility grid connect with inverter is simple, efficient and trouble free.

NET METERING:

Simple put, "net metering" allows homeowners with solar energy systems to save money by selling extra electricity back to their utility grid during the day when the solar collecting system is producing more power than the building or home is using. Essentially, the building's electric meter runs backwards during this time to deliver electricity back to the utility. And the customer gets credit for that amount of electricity on the following electric bill.

With net metering, utility customers obtain the benefits of solar energy regardless of whether they are using electricity at the same time their system is generating power (for example, while they are away during the day). Then, at the end of the month, if the customer uses more electricity than they generate, they pay the utility on the net kilowatt hours they use at the regular retail rate. If the customer generates in excess of his usage, the utility pays him for the net kilowatt hours produced, in either the wholesale power rate or the net rate the utility changes regular customers, depending upon the utility's policy. Other than the solar system, no special equipment is required.

(#2.) SOLAR HOT WATER HEATING:



The Four Seasons Solar Hot Heating Water System was developed by scientists from the National Institute of Standards and Technology.

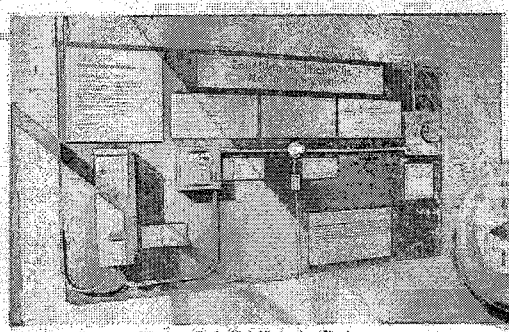
SOLAR HOT WATER HEATING:

Four Seasons Solar Products has been awarded exclusive use of the patent for an advanced and thoroughly tested new PV hot water system. This system was developed by scientists from the National Institute of Standards and Technology (NIST). Unlike the first available commercial solar water heating systems that used a liquid, either water or a type of antifreeze, to collect and transmit heat, the new Four Seasons PV water heating system uses no fluids and needs no hoses or tubes. By eliminating the water, the system reduces all the durability and installation issues that plagued the old systems.

Unlike other residential photovoltaic (PV) systems, the photovoltaic solar water heating system does not require an inverter to change the direct current to alternating current and does not require a battery to store the energy until it is needed (the water tank effectively acts as the storage medium).

Energy consumed for water heating accounts for approximately 17 quads of the energy consumed by residential and commercial buildings (U.S. Congress, 1992). According to the U.S. Department of Energy, an electric water heater supplying a typical U.S. family consumes approximately the same amount of energy per year as a medium sized automobile driven 12,000 miles per year. For over a century, attempts have been made to reduce the vast quantity of nonrenewable energy consumed for water heating through the use of solar water heaters.

Developed By NIST



The Four Seasons Photovoltaic Net Metering System is simple and efficient.

NET METERING...
Or Having Your Meter Run Backwards And Selling Your Electricity Back To The Local Utility "Power Grid"!

APPENDIX L

New and expanded environmental responsibilities for architects from RIBA 'Plan of Work'

A. Inception
- Brief client on new environmental duties
- Place 'environmental duty of care' within the brief
- Advise on environmental consequences of site choice

B. Feasibility
- Test the feasibility of environment-friendly design
- Advice on appointment of 'green' consultants
- Investigate environmental consequences/opportunities of site

C. Outline Proposals
- Develop 'green' strategies in design
- Obtain approval for unusual energy use or environmental aspects of design

D. Scheme Design
- Finalise environmental parameters within design
- Check the 'green' approach to design and construction against cost and legislative controls

E. Detail Design
- Obtain final approvals for environmental design strategy
- Undertake broad appraisal of 'life-cycle' assessment of components

F. Product information
- Ensure that design, details and specification are in line with current environmental duties and using up to date knowledge

G. Bills of quantities
- Check that bills of quantities allow contractors to realise their environmental duties in building

H. Tender of Action
- Obtain 'Environmental Policy Statement' from tenderers
- Advise tenderers of environmental duties

J. Project Planning
- Advise appointed contractor of environmental duties and standards

K. Operations on site
- Monitor site operations to ensure good environmental practice is followed
- Undertake spot checks of environmental performance

L. Completion
- Ensure building is environmentally sound
- Check environmental controls are working and understood
- Compile 'Environmental Statement' for building.

M. Feedback

- Monitor environmental performance of building
- Disseminate results of environmental initiatives in journals
- Prepare a user manual for all subsequent owners/occupiers

Source: Edwards, Brian. Sustainable Architecture. 2nd ed. London : Architectural Press, 1999, p.261

APPENDIX M

Prof.Dr. Ken Yeang's Curriculum Vitae

Architect- Architectural Association School, London (1966-1971).
Doctorate- Cambridge University (Wolfson College), England (1971-1975).
Landscape planning studies- Department of Landscape Architecture, University of Pennsylvaina, USA (1973).
Professor- Graham Willis Chair, Sheffield University
Adjunct Professor- Royal Melbourne Institute of Technology.

Professional Service:

- Vice- Chairman Council of Tall Buildings and Urban Habitat (COTBUH) (1993-1996).
- President of Malaysian Institute of Interior Designers (1994-1995) Council Member of the Malaysian Institute of Architects (PAM).
- Past Chairman, ARCASIA (Architects Regional Council Asia) (1986-1988).
- Past Board Member of Government of Malaysia's Board of Engineers (1986-1988).
- Past President Malaysian Institute of Architects (PAM) (1983-1984) (1984-1985).
- Past Vice-President Commonwealth Association of Architects, London (1983-1985).

Source: http://www.tt.fh-koeln.de/eco/ECOKEN .htm

APPENDIX N

Ken Yeang's Books:

Tropical Verandah City (1986)

Tropical Verandah City is the documentation about Yeang's ideas about the urban design and planning of cities. He describes the image of the Tropical city as a tropical urban garden. Natural sun lighting, rainfall, cool breezes and the close presence of nature effects gardens as well as the cities. However the current cities are designed to protect from all the natural conditions. With the development of mechanical and electric systems, many buildings prefer to use air conditioning instead of using prevailing winds.

Tropical Urban Regionalism (1987)

Tropical Urban Regionalism examines Yeang's ideas on building in the context of Kuala Lumpur. It articulates the need of the newly industrialised and developing countries for an architecture and urban from that reflects cultural and climatic influences in a way that international modernism has often failed to do' (Yeang 94; p8). The book is divided into four sections: ' On Building and Thinking', ' Regionalist

Design Intentions', ' An Armature for Interpretations' and 'Consequences On Building and Thinking' is a reflection by Yeang upon the state of architecture in the tropical context. He laments the fact that Asia is in an 'architectural backwater of debate'. Yeang goes on to detail the idea of the building as an 'environmental filter', stressing that his intention was not to provide a prescriptive manual, but simply to give an analogy that could be used for design synthesis and analysis.

'The emergent regionalist architecture' Yeang writes, 'seeks architectural significance through relating its built configuration, aesthetics, organisation and technical assembly and materials to a certain place and time.' This is vital connection that links technology with culture. Indeed, there are several connections:

Firstly, a direct connection which involves the creative adaptation for contemporary uses of an existing range of built forms; secondly, an indirect (abstract) connection, through the interpretation into form, by design, of the general principle derived from

an analysis of architectural heritage and cultural traditions; thirdly, an inclusive contemporary connection in design through the selective use of current technology, forms

and ideas; fourthly, a landscape connection that integrates the building with the physical context and natural history; and fifthly, and perhaps most importantly, a forward connection in which design considerations include an anticipation of the likely consequences of the building. The last two 'connections' foreshadow Yeang's later focus upon environmentally responsive architecture.

Bioclimatic Skyscrapers

Yeang's book **Bioclimatic Skyscrapers** illustrates his projects between 1986 and 1993 that apply Yeang's ideas on environmentally responsive design to a variety of buildings in China, Vietnam and Europe, as well as several towers in Malaysia. Most of the sun-path diagrams[1] relate to projects designed for locations in the tropics, but some of the new towers are designed for subtropical or temperate climatic zones.

Yeang's book **Bioclimatic Skyscrapers** intent to describe Yeang's theory and practice. He shares his design agenda with other architects. There are two types of information is available for them. First one is how he dealt with existing theories, and second one is new ideas formed from his buildings. One clear development he has is how he developed his ideas in previous buildings and how he dealt with the problems occurred in his next building. For example, Menara UMNO, completed in 1998, proved the effectiveness of wing-walls[2]. This principle will be refined and will find its way into other projects. This continuous progress is key part of Yeang's design agenda.

The Architecture of Malaysia

The Architecture of Malaysia was about Malaysia's architectural heritages between 1890-1990. In his book, Yeang investigated past building traditions of Malaysia which is located in the tropical climate that produced traditional tropical designs on verandahs and terraces. Yeang believes that a Malaysian architecture for the 21st century, very different from its historical origins (Yeang,1994; p14).

Yeang discusses the period following Malaysia's independence, a time there was a strong surge of nationalism and search for identity. In parallel with the huge political and social changes then under way, some Malaysian architects were beginning to question the validity of Western models. In 1978, in a seminar organised by the Ministry of Youth and Culture outstanding architects spoke out on the issue. At the same time, political premiere was, leading some architects to replicate traditional elements such as Islamic arches and roofs, Indian roofs and Chinese cultural influences in their designs. Yeang was uncomfortable with

[1] **Sun Path Diagram.** Sun path diagram indicates the cardinal points of the compass and the path of the sun, with its seasonal variations in the latitude in which the building is located, superimposed upon a plan of the building correctly oriented.
[2] **Wing-walls.** Vertical walls constructed as an integral part of the building fabric, maximising wind's cooling and ventilation effect.

this direct replication of vernacular elements, having investigated the past traditions of Malaysia's architecture in his book, The Architecture of Malaysia between 1890 and 1990, recommended a re-interpretative approach and the adaptation of architectural models that were responsive to Malaysia's climate without trivialising its deep culture, traditional forms and decorative motifs' (Powell, 99; p15).

Design with Nature

In 1995, his thesis published as 'Designing with Nature'. The book is Yeang's updated doctoral thesis titled A Theoretical Framework for Incorporating Ecological Considerations in the Design and Planning of the Built Environment and it provides the theoretical framework for his design agenda. The title of the book is same as Prof. Ian L. McHarg's[3] Design with Nature (1969). Yeang says it's not a coincidence because the content of Yeang's book 'takes off from where McHarg finished. Mcharg is a landscape architect and planer, so his book took ecological design up to planning level, where as Yeang's book takes ecological design up to level of architecture (Powell,99; p 72).

The Green Skyscraper

As Yeang has become increasingly focused upon environmentally responsive design strategies, his terminology has undergone a further shift in emphasis (Powell 99; p99). 1999 publication of **The Green Skyscraper**, contains Yeang's recent thinking and design methodology. The fundamental ideas have been introduced in previous publications by Yeang, but increasingly evident in this book, is an solemnity in his language and the contention that without a concurrent effort by humankind to incorporate ecological design 'our widespread activities as a species in the biosphere will in time overload the carrying capacity of the other species and the natural systems of the planet.

Source: Powell, Robert, (1999), Rethinking The Skyscraper, Thames & Hudson, London.

[3] **Prof. Ian L. McHarg's** is a landscape architect, planner, teacher and writer who headed the Department of Landscape Architecture and Regional Planning at the University of Pennsylvania, where Yeang studied for a semester in early 70s.

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DOKÜMANTASYON MERKEZİ

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