

AN ANALYTICAL STUDY ON SUSTAINABILITY IN URBAN ARCHITECTURE
WITH SPECIAL REFERENCE TO RESIDENTIAL BUILDINGS IN COLOMBO.

A Dissertation Submitted to Department of Architecture of the



University of Moratuwa
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In partial fulfillment of the requirements for the degree of

Master of Science in Architecture

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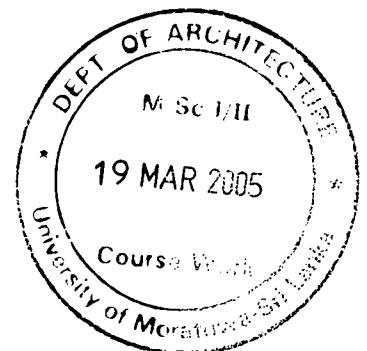
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UOM Verified Signature

Dissertation tutor
Senior lecturer
Archt. D. P. Chandrasekara.

UOM Verified Signature

 author
Sarani Kulasinghe B. A.
MSc. II

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Sustainability in Architecture



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Forward

The Architect must be a prophet,
A prophet in the sense of the world;

If he can't see at least ten years ahead then

Don't call him an Architect.



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Frank Lloyd Wright

Abstract

Although man seems a much-developed creature from his days of the jungle, he still is a part and parcel of a natural order of things. Man's development is reflected through his construction and technological improvements. Yet these in the long run has incurred damage and lost to the environment. Therefore the 20th century, foreseeing a future crisis and already arisen problems, became much aware of the issue of sustainability. This is an attempt to understand the broad scope of sustainable design. This study is a distillation of existing sustainable design theories, strategies, principles and guidelines with a focus on an urban Residential Buildings.

A holistic perspective on this topic result in a much clearer understanding of the concept of sustainability, as well as a better grasp of how to steer the design industry towards more sustainable practices. It is important to note here, that this study is focused on sustainable design applicable to urban context and Residential Buildings. In the actual situation, the designer can never hope to reach absolute sustainability, but must strive to approach it to the limit of his capabilities. This analogy underlines one of the main goals of this study, that is, to take the existing knowledge of sustainable design, which has so far been applied in bits and pieces, and combine them all to create the most complete strategy possible.

Introduction

Observation

Sustainable Architecture, in the 70's and early 80's has been a concept practiced away from the cities and people could afford to live in a country side cottage, grow their own vegetables etc. But today, in spite of the still remaining bad effects of the city, people are willing to and most attracted to live in the city. Due to these reasons, the European urban cities which consumes a major amount of energy in their day today activities, has shown interest in sustainable practice in urban context. Further it was observed that sustainable practice could be introduced in to every piece of Architecture with out much difficulty in grass root level. It is this observation which brought the main ideas behind this dissertation

Critical Nature of the Problem

Though architecture man alters earth, and uses up its resource coursing irreparable damage. Architecture or rather building construction is one major area where there is consumption of resources is high.

This dissertation considers the immense consumption of energy through building and looks at its, still immense possibilities of minimizing of energy consumption by using creative and inventive thinking in architecture. The environmental and energy crisis of the world has come to such a critical state, energy consumption on earth every action of man should be conscious of the problem. In this scenario, Architects has immense responsibility in the decisions they make from the design stage to Building construction.

Intention of the Study

This dissertation focus on sustainable architecture in urbanity as a pressing need for the contemporary times two major factors are looked at in the relevance of sustainability in urbanity. Firstly it was understood that the process of urbanization cannot be curtained, cities are becoming home for more and more people. Secondly cities do consume a massive amount of energy and cause great deal of damage to the bio sphere. Therefore this focus on to two main areas in architecture: one is to explore how creativity can exceed the restrictions placed by the urban context in achieving sustainability. Further to express the simple yet efficient strategies that can be practiced on a regular basis to achieve sustainability. Sustainable architecture is a response to awareness and not a prescriptive formula for survival. It is a new attitude and way of looking at the world. It demands that the expectations for material qualities in our lives must be decreased it represents mane survival at the expense of improved quality of life.



Scope and limitations

'Sustainable' architecture could not be defined clearly by drawing a line. It could be vague and quite undefined. Therefore the dissertation one has to work with in a theoretical framework of definition for sustainable architecture. Issues of sustainability and sustainable designs are extremely broad and wide ranging. Therefore Sustainable design could have many different meanings and interpretations depending on perspective and scale. Much of this has been discussed in chapter one.. The nature of sustainable design holds the designer responsible for all the environmental effects of the design on the eco-system. Taken to the extreme, this would mean that the designer must take the entire earth's eco-system into account.

Area of the study is too vast and has to be narrowed down to residential buildings facilitate the study with the time frame. My own personal architectural background and preference for physical design issues channeled this study toward a design perspective as opposed to a planning perspective. Being an architectural thesis, "hard" or physical design issues will be the priority of this study. Economic, social and political issues of sustainability, although equally important, are not as readily accessible to strategies of sustainable design and therefore, will be addressed only in relation to design issues. And this study should show that there is a need for studies on the sustainability of urban system.

Method of study

The study would be carried out from a theoretical framework. A clear definition for sustainability is needed. The relationship of architectural style and sustainability has to be established. This hypothesis is to be proved through case study. It intends to establish a good parameter to scale "sustainability" within the framework of study.



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Chapter ONE

Sustainability in Architecture

Chapter ONE

Sustainability in Architecture

Preamble

It was understood that the concepts of sustainability are discussed with much emphasis these days, yet it not a novel idea, but our ancestors has been leading a sustainable life where there was, coexistence and respect to surrounding environments. Further the concept of sustainability is not abstract theories, but is an attitude which can be adopted in various levels. This chapter discusses the relevance of “sustainability today and its particular relevance in the field of architecture as an introduction to the topic; sustainability and urban architecture.

1.1 Sustainability- an Introduction

1.1.1 Sustainability- as age old wisdom

Sustainable attitudes are not alien in early societies. Our ancestors with their close communication with nature understood the holism in the ecological system and were a part of it. They knew the natural order and natural balance maintained in nature. They were aware that every little creature, every insignificant micro organism was given a niche, a place and role of their own for the well being of the ecological system. They were careful and sensitive enough, not to disturb the great invisible living force of nature. Although “sustainability” was not discussed as a subject, it was in practice.

As man gradually ported from the natural order, finding his own ways, with the advent of science, this inherent knowledge fell apart. Man become insensitive, to and irrespected the body of knowledge which helped to keep the balance of the ecosystems.

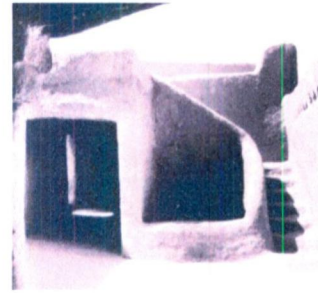
Fig. 01
Making ones own home: home making is a family act, and mud plastering is always confined to women.

Source: Romero, O (1994), p.23



Fig. 02
Mud house

Source: Romero, O (1994), p.28



1.1.2 Sustainability- Relevance

"The whole world today harbours feeling of misgiving over the crisis facing the global environment and the general loss of our spiritual culture. Now more than ever, it is time to return to our point of origin, to deepen our understanding of the environment and to correct our ways of mishandling the earth's forests and woodlands which play such an important role in shaping and developing the human spirit."

Tadao Ando, 1998, p07

All over the world, we are finally beginning to realize the results of mishandling the nature and its resources. We have used up resources carelessly, which has been a products of billions of years of solar energy. This careless using of irreplaceable resources has thrown the entire global ecosystem out of balance.



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Economic development has wasted limited resources and had deserted

The environment bringing momentary prosperity; it lacks sustainability and threatens the existence of future generations. Now is the time to change our consciousness in this regard, and to come up with appropriate means of utilizing our resources.

Fig. 03
Deforestation
Tofino Creek, Canada
1993

Source: Wines J. (2000),
p.30, 31



Fig. 04
Excessive drought
Senegal, 1997



1.1.3 Sustainability- A definition

"Sustainability" has become a buzzword or symbol describing this inevitable on going transition. As such, the term sustainability has little to do with; but is the name for a new attitude and way of looking at the world. "

Jack A. Kremers, 1987, p. 42

"Sustainability" is a vague term used to mean an attitude; an attitude which can be adopted by not only environmentalists, but from architects, engineers, product designers, factory owners to house wives. Sustainability is not about conservation of nature. It is a multi faced concept, which has social, cultural and environmental faces and is more oriented to development. Sustainability is about appropriate development, cleaver and wise use of resources, using the right source at right place.

It is a *"path of progress which meets the need and aspiration of the present generation without compromising the ability of future generations to meet their needs."* Gro Harleen Bruntland, 1987

1.2 Sustainability and Architecture

1.2.1 Sustainability as Architect's Responsibility

Architects create the enclosure for people to live in, families to thrive and children to grow. These enclosures could be mere buildings which comprises the physical requirement of the user, but could be insensitive to various other factors which plays a significant part in the user's life in an intangible way.

"Housing means much more than just a roof over one's head; it also means privacy, adequate space, security, structural stability and durability, with proper lighting and ventilation, as well as an adequate infrastructure, sanitation and waste management."

Herbert Girardet, 1992, p.13

Along with the architect's immediate responsibility to the satisfaction of deeper and inner needs of the client, he has a global responsibility in his hands, which he cannot overlook. It is not difficult to see the architect's responsibility in respect of sustainability, all the decisions an architect would make, from the design stage to the construction of the building, could affect the ecological balance of the earth in a major way.

Fig. 05
Transporting earth

Source: webmaster@auroville.org.in



Fig. 06
Construction site

Source: webmaster@auroville.org.in



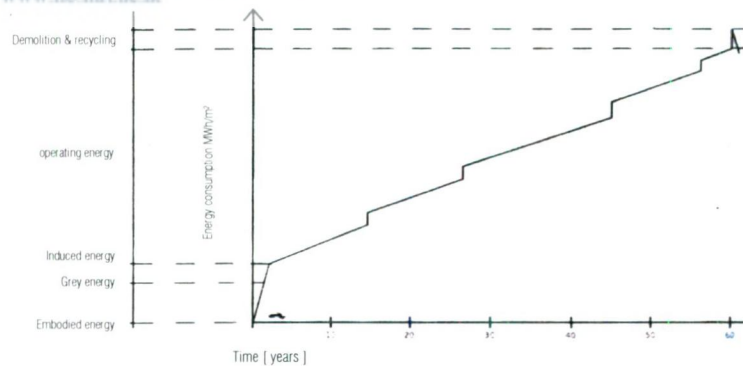
Buildings consume energy in a number of ways; as David Lloyd Jones discusses in his book; architecture and environment;

- 'Embodied energy; In the manufacture of building materials, components and systems.
 - Gray energy; In the distribution and transportation of building materials and components to the construction site
 - Induced energy; In the construction of the building
 - Operating energy; In running the building and its components equipments and appliances
- A building also consumes energy in its maintenance, alteration and final disposal.

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Fig. 07
Chart: energy consume in the life of the building

Source: David Lloyd Jones, 1998



1.2.2 Sustainability- principles in practice.

Sustainability, as it is discussed here is not a single, clear cut idea or a theory. It is rather an attitude, which could be adapted by one self to the extent that one is willing to do so; therefore the principles of sustainability too are holistic ideas, board, interconnected and vague to a certain extent.

Architect Mc Donough, presented the principles of sustainability to the 2000 worlds fair, Germany, Hanover, which have since become a mainstay of the sustainable design movement.



1. Insist on rights of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition.
2. Recognize interdependence. The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.
3. Respect relationship 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 of long-term value. Do not burden future generations with requirements for maintenance of vigilant administration of potential danger due to the careless creation of products, processes or standards.
6. Eliminate the concept of waste. Evaluate and optimize 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 design should, like the living world, derive their creative forces from perpetual solar income. Incorporate the 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 model and mentor, not an inconvenience to be evaded or controlled.
9. Seek constant improvement by the sharing of knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.





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Chapter TWO

Urbanity and Sustainability

Chapter TWO

Urbanity and Sustainability

Preamble

This chapter focuses on the concept of urbanity. It was observed that inspite of the negative image prevailed for cities as “corrupted and polluted places”; in the modern day urban living has become an almost essential for many reasons. Further it has become a “way of living” which modern cities, among other things are aptly defined by their demand for energy. Therefore in the middle of energy crisis and concern for sustainability, this is an effort to discuss the city as a sustainable entity. This chapter will contain a history of cities in nutshell and its turning points after industrial revolution and the concepts of modern city.

2.1 Concepts of Urbanity: an historical perspective

Cities reflect man’s process of civilization. They are a physical representation of the ideas, ideals and value systems of the age of their creation. Whatever their main goals have been, urbanity poses common under laying characteristics in their social, physical and economical aspects. The cities emphasis on public spaces such as parks, squares, for communal activities, road networks, public buildings and private buildings. Therefore cities always are dense with population and intense with activity. And more prone to industrial activity than agricultural.

Fig. 08
The Acropolis
Athens, Greece, 5th century B.C.
Source: Wines, J. (2000), p.53



2.1.1 Medieval cities

The medieval age, although is called the dark age, due to the persisted “ignorance” on world wide matters in general, has produced beautifully woven tight and picturesque cities. They are mostly associated with narrow winding streets converging on a market square with a Cathedral and a city hall, and most prominently a city wall for protection. The city expanded in the city wall, as tight as it could be in adhoc; improvise fashion to accommodate the requirements. As the cities expanded, new walls were built enclosing more land and out grow from its former container.

However these cities due to its various circumstance mainly, defense, become tightly connected and formed very efficient modules of cities due to its very density.

Further however urban, the medieval cities had a pleasing aesthetic and a human scale nature in to its formation; in the built form, in layout in inter meandering Rds etc. which even today preferred for exclusive living and as tourists destinations in Europe.

Fig. 09
Hill Town
Southern Italy
c. 1400
Source: Wines, J. (2000), p.07



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2.1.2 Renaissance

Man was empowered by Renaissance; the rebirth of sciences, and knowledge. Man expressed this sense of power and control physically in the city structure: grate public spaces, elegant squares, long street vistas, symmetrical building arrangements etc were created as an expression of man's power as contrary to the medieval cities which were more humble, and followed the natural contours.

2.1.3 Industrial cities.

Industrial revolution was a turning point in history in many aspects. Cities were changed more since the industrial revolution than in all the previous centuries of their existence. 'Industrial Revolution' affected all the aspects of human life; cultural, social, and economical. With the introduction of 'machine', it posed unforeseen complexities and complications in moralities of people behind the "wonders" it promised in its face.

Fig. 10
Aerial view of Caracas
Venezuela, 1993
Source: Wines, J. (2000), p10,

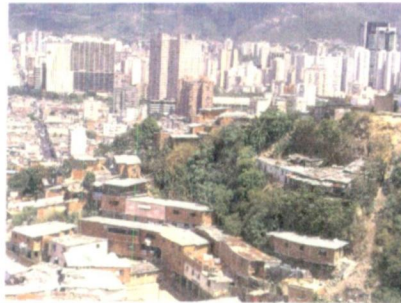
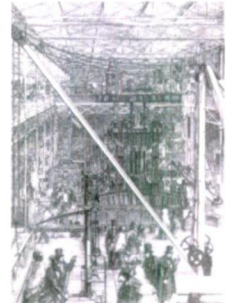


Fig. 11
Great Exhibition, 1851.
The Machinery court in the Crystal Place
showing a crane in the foreground and a
hydraulic press at the back.



Source: Frank Whithford

"While ordinary mortals were thrilled and fascinated by the wonder of Paxton's creation, a small number of thoughtful people were horrified by what it contained."

Frank Whithford, 1984, p.13



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"The industrial revolution precipitated a crisis in architecture. It was not simply a question of whether architects might legitimately employ a question of whether architects might legitimately employ new building- materials and of the forms the use of such materials might demand. It was also one of devising solutions to the problems created by the stupendous and distressing growth of urban populations. How and where the new urban proletariat to be housed?"

Frank Whithford, 1984, p.17

With the population concentration cities were, posed with new problems of housing, living standards, hygiene etc. Further the industrial revolution brought forth issues of environmental pollution. The negative image of the city as a polluted, corrupted and deteriorate place was created due to various, physical as well as social and economic complexities that sprang up due to the consequences of an unexpected population streaming in to cities. Since the cities could not absorb the population streaming in to the cities, and stand the vibrations created through all the sudden changes, its social economic and moral structures were uprooted. Cities become deteriorated and sterile physically and morally; therefore after a while, people started longing the peaceful country sides, the fresh air and greenery emphasizing a negative image of the city.



2.2 Modern urban city

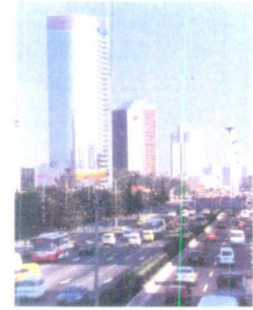
1.2.1 Characteristics of urbanity

Yet today city has become the greatest attraction of populations due to various reasons such as opportunities presented by city life, exposure, entertainment and public life.

Fig. 12
New Hong Kong- skyline- night

Fig. 13
New Beijing: gridded by roaring
highways

Source: Architecture Review,
August, 1999



2.2.2 Living in the city

In "urbanism as a way of life", Louis Wirth, defines city life through three main features.

- Large size
- High density
- Social heterogeneity



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"Large numbers account for individual variability, the relative absence of intimate personal acquaintanceship, the segmentalization of human relations which are largely anonymous, superficial, and transitory, and associated characteristics. Density involves diversification and specialization, the coincidence of close of close physical contact and distant social relations, glaring contrasts, a complex pattern of segregation, the predominance of formal social control, and accentuated friction, among other phenomena. Heterogeneity tends to break down rigid social structures and to produce increased mobility, instability, and insecurity, and the affiliation of the individuals with a variety of intersecting and tangential social groups with a high rate of membership turnover. The pecuniary nexus tends to mass rather than individual requirements. The individual thus becomes effective only as he acts through organized groups"

Louis Wirth, 1980 p.13

The city dweller lives a busy life spending little time in his own house. This accounts to the small size of the city residences, mostly apartments in condominiums or storied houses in a plot of land of smallest stipulated size.

Fig. 14
Urban housing
New York, USA
Source: Wines. J.(2000),
p.25



Wellawatta, Sri Lanka

Therefore “urban residences” acquire a certain characteristic quality, unique problems and a unique living style the main features of urban residence could be listed down as follows and would be discussed in detail later in chapter three.

- Limited spaces due to limited land.
- Low rating for maintenance.
- Lack of garden space or very little garden space- breathing space.
- Lack of privacy or very little privacy.
- Direct relationship with the access road
- Communication with neighborhood due to busy lifestyle- social interaction.
- Heat due to the urban heat island.

2.2.3 Urbanity and sustainability



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“Life in the cities of the 21st century will be greatly influenced by decisions made at the end of this century, in the same way in which we are still crucially affected by decisions made in the 19th century. It is vital, therefore, to get things right. In the world of cities, the decisions they take on how to use energy, how to supply themselves with resources and how to deal with their wastes are crucial for humanity, and indeed, for the biosphere on which it depends.”

Herbert Girardet, 1992, p.13

In spite of the prevailing problems that exist in urban areas, and urban living, cities have become “our main home” today. Yet the concept of ‘sustainable cities’ has come up due to various innovative possibilities on almost all the aspects of urban life. What is required is an attitudinal change to shift the new, resource efficient technologies, theories that are coming in to play in Europe mainly.

It is also suggested that their very density makes for energy efficiency in transport systems, for waste recycling are more easily organized, urban agriculture, rainwater harvesting in densely inhabited areas.

The city of the future, to be sustainable, will have to move towards a new concept of civilization; will have

with grater dependence on local consumption, with much grater concern for the livability of local environments, and with greater emphasis on creating public spaces for people to enjoy, with streets as living spaces as well as transports.

Fig. 15
Trafalgar square
Source: Architecture
Review, May, 2000



Architects and planners have a great responsibility to help create receptiveness for the emergence. For the emergence of the new kind of architecture that combines climatic responsiveness with functional efficiency and a pleasing appearance. This is an ethical responsibility that transcends the traditional brief of the profession, with cities as our main home today; we have to redefine their cultural and environmental function.

There are already architects working intensely on these issues creating ideal living examples of cities such as Auroville and Curitiba where the community had expanded all its bounds for a one common goal. These would be discussed later in this dissertation.



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Fig. 16
Construction –excavation – Auroville- universal
township
Source: webmaster@auroville.org.in





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Chapter THREE

Sustainability in Urban Architecture

Chapter THREE

Sustainability in Urban Architecture

Preamble

Chapter three focuses on the sustainable practice in both the city scale as well as the scale of individual buildings. Sustainable urbanity was understood as a concept which has its roots in the urban boom after industrial revolution and the green revolution has started, as a movement of getting away from the city. This is discussed as an act which is not sustainable in it self in today's context. Today the city has become the main home for most of the populations, what is important is the sustainable practice in city itself. Second part of the chapter discusses the sustainable strategies which could be easily adopted in any building which shows sensitivity in today's context.

3.1 Urbanism and sustainability as two contradiction concepts.

3.1.1 City as a major user of energy.

1976 UN held its first global conference on human settlements: Habitat I in Vancouver, Canada. [1976] At that time there was still hope that rapid urban growth could be curtailed. Habitat I drew international attention to problems in all kinds of settlements, rural as well as urban. 'Habitat II' built on this effort and focused on the urbanization process itself, at a time when cities and towns are coming close to accommodating a majority of the world's population. Urbanization has turned in to the dominant feature of the human presence on earth.

Governments world- wide are increasingly aware that efforts to improve the conditions of the earth's environment must focus on the major urban centres. Cities today dominate global resource consumption. They take up only 2% of the world's land surface, yet they use over 75% of the world's resources. Sustainable urban development is, therefore, the most pressing challenge facing humanity in the 21st century. Could the vast appetites of cities for resources, and their huge waste discharges, be curtailed?

Fig.17
Nuclear power station
Sir Basil Spence
Trawsfynydd, Wales
1959



Fig.18
"Aegean Sea" oil spill
La Coruna, Spain.
1992

Architectural issues – the materials used in buildings, the compatibility of architectural design with climatic conditions, energy use and environmental performance of buildings were key aspects of Habitat II. The impact of cities is felt locally and globally city population, as major users of energy, cause both regional and world- wide air pollution, with dramatic impacts on the health of people and of the biosphere.

Sustainable urban development is of critical importance for establishing a viable relationship between humanity and the global environment. Cities today have the historic opportunity to implement technical and organizational measures to this effect.

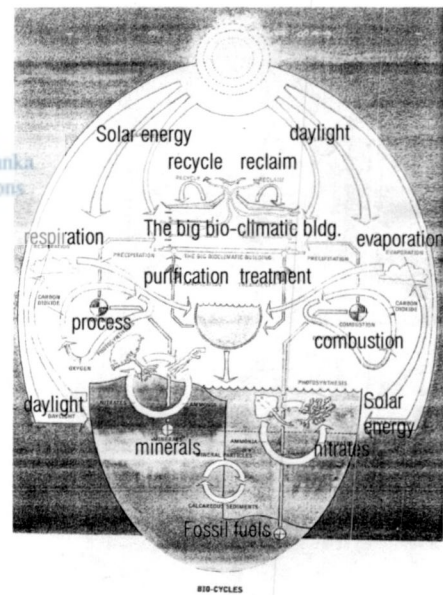
Human settlements shall be planned, developed and improved in a manner that takes full account of sustainable development principles and all their components. We need to respect the carrying capacity of ecosystems and preservation of opportunities for future generations. Production consumption and transport should be managed in ways that protect and conserve the stock of resources while drawing upon them.

Fig.19
Bio- Cycles

Source: David Lloyd Jones, 1998



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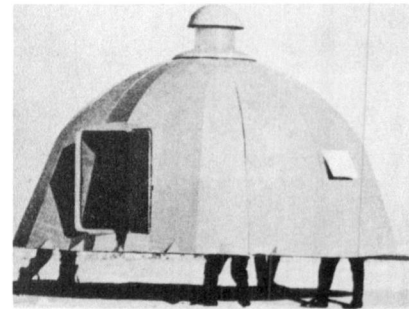


3.1.2 Green solutions – away from the city

In the early 70s, many thought that the best way to respond to the environmental crisis was simply to abandon the cities and to start afresh with a cottage on a plot of land or some idyllic new village deep in the country side. Getting away from the corrupted city was in many of who saw the explosive growth of urban consumerism and its destructive effects on the environment. In response to the demand for new ecologically oriented lifestyles in the early 70s new designs for eco-efficient buildings started to appear. A tranquil life in the countryside promised more of a future than the urban rat race. Millions moved in to empty cottages, derelict farmhouses and converted barns, all over Britain. The idea was to live close to

nature, grow your own food, bring up your children in a rural setting and, to do all of this living in a house with a built in green house where you could produce much of your hot water from solar energy and where you could produce much of your hot water from solar energy and where you could be happy ever after.

Fig. 20
Portable architecture
Cohos Evamy Partners
Alberta, Canada
1967



Source: Source: Wines, J. (2000). p. 26

However, much of these green settlements were prevented by the planning laws as they are scattered on low density on Britain's countryside. In the mid 80s, a new village called 'light moor' was built at Telford. The unique thing about light moor was that the future inhabitants designed the layout of the site. Built there own homes shared decision making and were able to create a village to meet their own special needs. It had 25 acres of ground with plenty of communal space, each house its own garden, growing their own vegetables, "a computer in the kitchen and pig in the back garden".

Although the idea of green villages was a wonderful experience, it was no way a solution to reduce global housing problems or urban environmental impact. World wide more and more members of people are moving in to larger cities abandoning rural areas, and agriculture becoming more and more mechanized. The habitat II in 1976, was specifically consumed about stopping the trend towards urbanization, and highly the appreciated the "green villages" but with no success, today it is very clear that process of urbanization could never be stopped. In the 19th and early 20th centuries, urban growth was occurring mainly in the northern hemisphere, as a result of the spread of industrialization and associated rapid increase in the use of fossil fuels. Today, world's largest and fastest growing cities are emerging in southern hemisphere, because of urban industrial development and rural economic and environmental decline, therefore, it is most crucial to examine how existing cities where most people how live can be made environmentally and socially sustainable.



3.1.3 Green solutions: in the city.

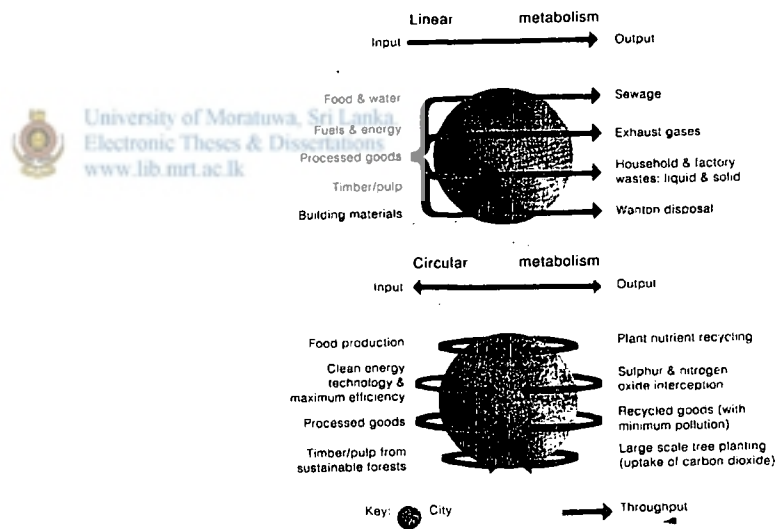
City growth is changing the face of the earth and the condition of humanity. Can the planet accommodate an urbanized humanity drawing its resources from an increasingly global hinterland? And can humanity learn to cope with urban growth and density whilst maintaining a stable relationship with the biosphere? In conventionally run cities, metabolic processes are usually linear- inputs and outputs are considered as largely unrelated.

"Trees are felled for timber or pulp, and forests are not replenished. Raw materials are extracted, combined and processed into consumer goods that end up as rubbish which can't be beneficially reabsorbed into the environment. Fossil fuels are extracted from rock strata, refined and burned, their fumes discharged into atmosphere. Nutrients are taken from the land as food is grown, and not returned. All too often urban sewage systems are linear, collecting human waste and discharging it in to rivers and coastal waters down stream from population centres."

Herbert Girardet 1996 p.12

Fig. 21
Linear metabolism

Source: Herbert Girardet, 1996, p. 12



Cities which develop a self-regulating, sustainable relationship will adopt circular metabolic systems concerned with the continuing viability of the environments on which they depend. Outputs are also inputs into the production system, with routine recycling of paper, metals, plastic and glass, conversion of organic materials into compost, returning plant nutrients to keep farmland productive.

Some cities in history adopted sustainable relationships with their hinterlands as the only assured way in which to assure their continuity. This applies to medieval cities with their concentric rings of market gardens, forests, orchards, farm and grazing land. Chinese cities have long practiced the return of night

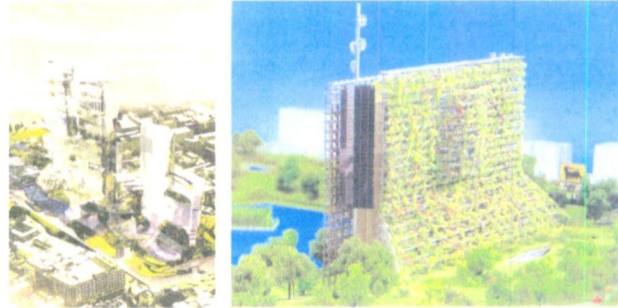
soil onto local farmland as a way of assuring sustained yields. Some modern cities too have made circularity and resource efficiency a top priority, installing sophisticated equipment for resource recovery. Such as waste recycling composting systems.

Fig. 22
Yeang's proposal for Bishops gate in London.
A style stronger than ecological imperatives?

Source: the Architectural Review, June 2002

Fig. 23
Proposal for a museum of American Architecture

Source: the Architectural Review, December 1999



3.1.3-a a universal town of Auroville , India

Today Auroville is a growing community of about 1,100 people from more than 30 countries. As a "place of an unending education and constant progress", Auroville has grown over the past 27 years into a community with multifarious activities, such as environmental regeneration, organic farming, alternative energy, village development, theatre, music, and art. Many of these activities are highly successful, though there are some constraints.



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In building done in Auroville covers various aspects of architecture, and includes building materials, building technology, eco-friendly architecture, climate responsive designs, integration with natural surroundings, cost-effective buildings, geomancy and geometry, as well as the design of spaces themselves, including experimenting with the lifestyle of the user. There has also been spillover into the design and management of building infrastructure, the building of integrated rainwater harvesting systems, domestic waste water treatment plants and the integration of renewable energy systems for energy demands.

Concerned with the ecological implications of energy consumption, Aurovilians have been experimenting with the use of renewable energy sources from the beginning. The major forms of renewable energy utilized in Auroville are solar, wind and biomass. At present, more than 1,200 photovoltaic (PV) panels are in use for electricity and water supply. Some 30 windmills of various designs are in operation for pumping water, and specially designed Ferro-cement biogas systems process animal and vegetable waste to produce methane gas and organic fertilizers. Today, Auroville has become a major testing ground for renewable energy sources in India.

Auroville has gained a considerable knowledge and expertise in the field of innovative, appropriate and cost-effective building technologies, especially earth construction and Ferro-cement.

Earth construction uses compressed earth blocks, made with a manual press from local earth mixed with 3-5% cement. The blocks are usually produced on the building site, without polluting the environment or depleting the forests, as no kiln firing is required.

In here all technical aspects are being fully considered. Take for example the problem of sound pollution. Says Dominic: "The design techniques to prevent sound pollution, even in the tropic, are developed and well known. The building will have a few hanging gardens, to enhance its beauty and increase the livability. There will be a green wall, all along one side of the building, to absorb the heat and give to the occupants the atmosphere of living in a green surrounding. Each apartment will have its own terrace, probably with a garden, so that full privacy is guaranteed. Underneath the building there will be a big water tank, and the water will be pumped upwards by solar pumps with solar panels positioned on top of the building"(1997).

Fig. 24

Town ship A universal city in the making in south-India.



3.1.3-b Ecological capital of Brazil-Curitiba

Curitiba has become the most sustainable of cities, in the process proving that applying a city-strategy with strong values and a focus on integrated systems can harness the actions of planning departments to meet common strategic objectives. Seventy percent of the city's trash is recycled. Residents who live in shantytowns get free groceries and bus tickets in exchange for their bags of garbage, and have access to social programs and health services funded by recycling programs. Recycling in Curitiba is now so advanced that two thirds of the city's daily waste is processed. Curitiba was awarded the highest environmental prize in 1990 by UNEP, and since its start in 1989 the recyclable waste scheme has accomplished the separation of 419,000 tons of recyclable waste – the equivalent of 1,200 20-storey buildings creating 280 square meters of trash each.

An unusual use of more low-technology methods is the 21-million square meters of parks, woods, gardens and squares within the city. Nearly one-fifth of the city is parkland, and volunteers have planted 1.5 million trees along the streets. The city has 200 kilometers of bike paths, and 52 square meters of green space per person. Such recreational facilities enhance the quality of life. Most of Curitiba's parks, called linear parks, are located along river banks and in valley bottoms. They help prevent illegal occupation and shanty town growth and reduce misuse as landfill sites. The park lakes are used to hold back floods and function as water flow regulators during the rainy season. The environment itself is the 'technology tool'

There's a model, inexpensive, speedy transit service used by more than 2 million people a day. There are more car owners per capita than anywhere in Brazil, and the population has doubled since 1974, yet auto traffic has declined by 30%, and atmospheric pollution is the lowest in Brazil.

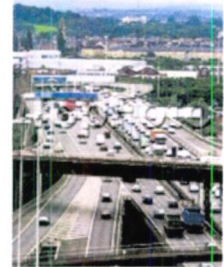
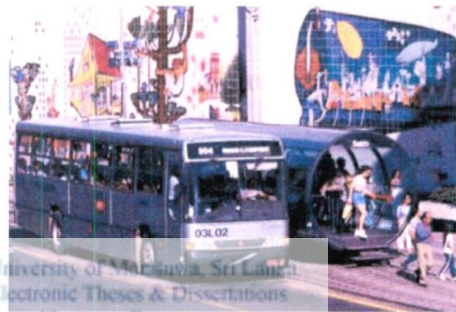
Fig. 25

Curitiba - Universal Township

Curitiba is a thriving example of how to 'dismantle' a problem before it starts.



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3.2 Urban Architecture towards Sustainability

Implementation of sustainability practices in cities need government level policy decisions made. This dissertation is focusing on a simpler ways of implementing sustainability through individual buildings.

3.2.1 Sensitivity to Natural Elements.

Natural elements are one major factor of consideration among other things, that a designer should take in to account this is two fold; the consideration in design to get protection from elements and to get advantage from elements. In a tropical climate like ours, one has to especially be aware of sun protection, heat gain, and tropical rain, where as, in tropical design it is all about inviting as much as possible wind in to the building, after shielding the other two. Using architectural solutions, options to get protection from elements and getting advantage of the elements conserves energy in a very practical and technical manner.

Secondly, it is sustainable to work with the existing factors of environment; sun, wind and rain are factors of environment and architect being sensitive to them drawing advantage upon them is but an obvious thing

3.2.1.a Orientation

In respect of sensitivity to sun rain and wind, orientation is the main factor of response. This is one of the preliminary decisions an architect should take in the design process. If building is orientated, with its short length facing east west, architect has solved one problem- reduction of solar gain, and sun penetration. Positioning of windows and window sizes has to be decided taking in to consideration the wind direction, as tropical buildings, it is very important to get cross ventilation through buildings to get away with the heat. Therefore it is important to place small windows at the bottom of the buildings to draw air in, and larger windows in the other side positioned in such a way to cross the room extent. Also one more important factor is to layer the building with shadings, shielding, eaves, verandahs etc to create a protective cocoon around the building.

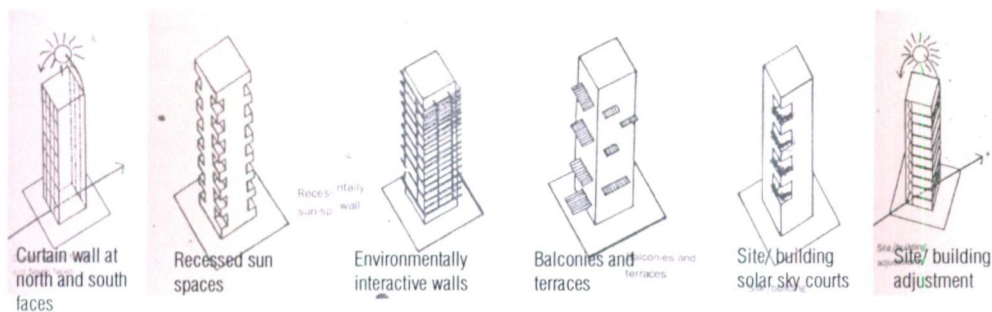


Fig. 26
Design principles
Source: Ken Yeang, 1994, p28



3.2.2 Sensitive use of Materials

This is one major decisive factor in sustainability as it is discussed earlier. Energy consumption in Buildings is in four different states, as Embodied Energy, Grey Energy, Induced Energy and Operational Energy.

Considering measures to build sustain ably, the architect should make some initial decisions on material use, which could intern effect the all four ways a building consumes energy.

3.2.2.a Choice of Material

First of all the architect must select materials, that in their manufacture, use little energy, there are materials that can be used close to their raw state such as stone, timber or compacted earth. Further to exploit the embodied energy, materials could be reused or recycled such as crushed brick, concrete, used bricks, used steel, waste materials from other processes etc.

Grey energy –that which is expended in transporting materials and components to the construction site can be minimized by support of local industries. And the use of local materials where there are no suitable local resources available, careful accounts needs to be taken of delivery distances and the mode of transportation.

Induced energy, the energy used in construction itself is normally modest in comparison to embodied energy and grey energy. How ever it is an important aspect of the overall management and running of the site, as ~~awe~~ efficient operation and health safety measures. The architect should ensure ,at tender stage ,that the builder has a comprehensive energy policy for site operations, including waste. Avoidance, economic use of water, eco-friendly disposal of demolished material etc.

Operating energy is the form of energy that has been given most consideration by researches. This is the energy used in consumption will continue as long as the building stands and is occupied.



Fig. 27
Drop city, Colorado, built of panels cut from the roofs of scrapped cars and vans.

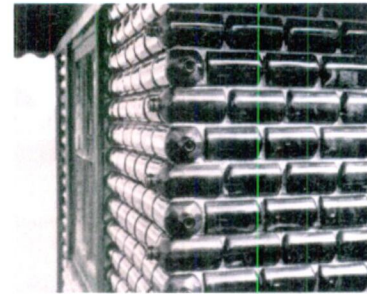
Source: Brenda and Robert Vale, 1996, p28



Fig. 28
Straw, generally viewed as an inconvenient waste product of agriculture can be converted in to useful building boards for partitions and interior linings
Source: Brenda and Robert Vale, 1996, p58

Fig. 29
Heineken's specially designed WOB0 beer bottles,
reused as a house wall

Source: Brenda and Robert Vale, 1996, p60



3.2.3 Sensitivity to Context

As sustainability is a one of co-existence with the existing orders, including the natural order as well as the social orders, of the context, Responsiveness in this regard is important. It is common practice to respond to site forces in the immediate context such as the shape of the site, terrain, views of the site features, relationship with the access road, relation ship with the neighborhoods etc.

A sustainable response would comprise of a design which shows regard for all the above factors and has minimum disturbance to the existing context. Further, the design solution should start a co-existence, an interaction with the elements in the site. Physically as well as socially too Fulfilling of these requirements would create a feel of appropriateness, a feel of "being a part of a group" which is the case always in the natural order of things. In nature, nothing is alone and stands out. Eventually energy living creature is woven a part of a elaborate process. Therefore the buildings too should be an active part of its context. Physically as well as an active member of the society that is placed.

Fig. 30
Brunsell Residence
Obie Bowman
Sea ranch, California,USA.
1987

Source: James Wines, 2000, p174



3.2.4 Respect for user

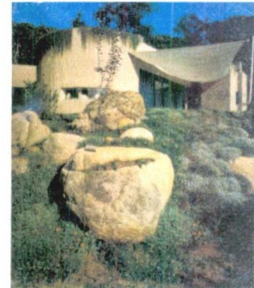
It may seem this topic has little to do with the sustainable issues, yet sustainability is a concept which takes in to account the existing as a whole. Therefore a building, to sustain it should be responsive to its user. the building should take in to account the more general once like the activity patterns of life styles of a user in its initial design stage ,and should achieve high level of functional efficiency. Therefore in an indirect way, it connects with sustainability further, the architect should take in to account the



preferences, tendencies, habits of the user when designing his personal space close communication with the user with regard to the space requirements, nature of the space etc would make user too involved in the process. This would again make it a sustainable product, well nurtured by the user, well balanced with his mindset so, he fits in more comfortably in his space.

Fig. 31
Harmony with landscape

Source: Brenda and Robert Vale, 1996, p28



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Chapter FOUR

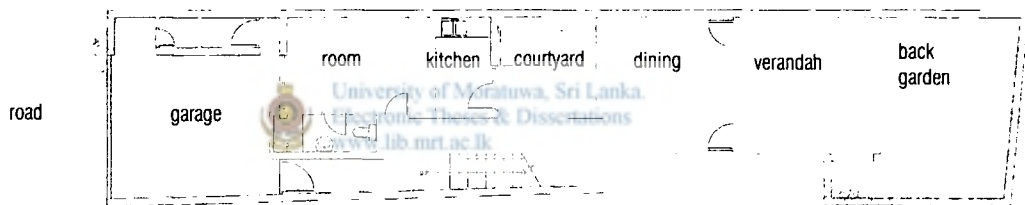
Case studies

Chapter FOUR
Case study one

Residence at Bauddhaloka Mawatha, Colombo 07- Designed by Archt. Hitanti Welandawe.

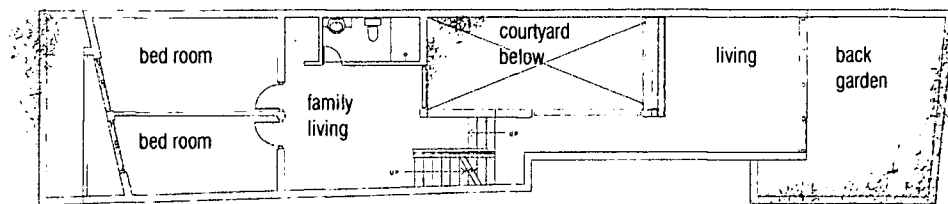
The site is located in Colombo 07, an affluent residential area where the residential land prices are at there heights most houses in this area are built in recent years span from boundary to boundary. Because plot sizes are becoming narrower, small and long; and have several floor levels with green space at roof levels.

This three storied building is on a strip of land, which is about six meters by twenty six meters with an east to west orientation. The north and south facades that are three stories high, which are on the boundary. Light is taken in from the east and west facades as well as the atrium in the middle, while the whole of the building opens out in to the atrium and becomes connected vertically. The roof terrace, two bed rooms that are on the first floor eastern half of the building and the master bed room is on the second floor, on the western half. The double height space in the living area combined with the atrium gives the feeling of spaciousness.



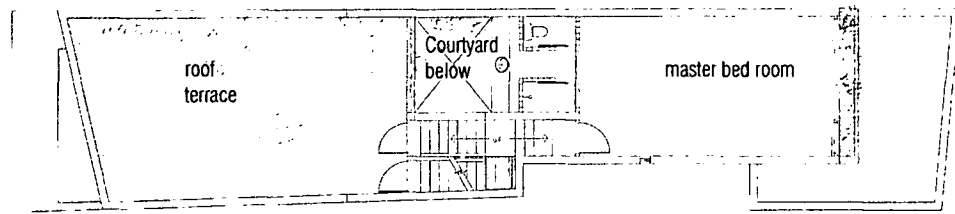
GROUND FLOOR PLAN

Fig. 32



FIRST FLOOR PLAN

Fig. 33



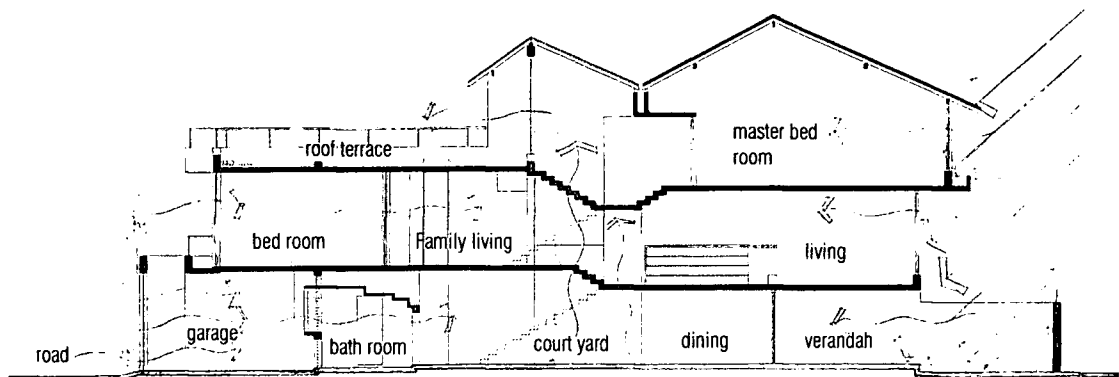
SECOND FLOOR PLAN

Fig. 34

The house has been designed for a nuclear family with a busy mother who looks after two toddlers and attends to all house hold matters etc. and a father being a professional. Therefore the house has been simple and compacted design solution one staircase connecting several levels in a middle courtyard and a triple height volume. All the spaces are visually interconnected through the void creating interactions through family which is valuable in the busy urban life.

The construction is of brick, mortar, concrete and wood. The external walls are 225 mm thick and have a coating of plaster where as the internal partition walls are only 112.5 mm and have a lime mortar plaster. Internal walls are painted white with one strip of wall is a deep marine blue. The external envelop of the building is painted white on plaster covering the 225 mm brick work.

South and the north facades are completely blank without any openings and the openings are to the east and the west. The wooden roof structure is covered with clay tiles.



SECTION

Fig. 35

Shading was achieved by introducing large overhanging upper floors and eaves. Other methods would include the use of tats, creepers and plants. The large overhangs on the first floor and the second floor do shade the western façade, but only for a limited time and after that internal blinds are used to control the glare. 'Palali' used as internal shades for minimizing solar heat gain and cut down the direct sun light from western side.

A major air movement towards the house is received from the rear side which can be identified as the positive air zone, while the secondary air movement from the front side should also be considered as an effective air flow.

The opening sizes of the windows and the louvered facades as well as the solids and voids- within the building control the internal air velocity.

The courtyard according to its position on the wind path is susceptible to the air movement created by wind pressure.

Fig. 36
Court yard



The court yard with a glazed roof is from 2 sides connecting to the triple height volume and from other side connects to the through a 7' 00" high grill work to the full width of the building; which expands the full width of the site. This connection to outside is a subtle mechanism to ventilate the house as the glass heat up it would draw up the stagnate air and release into outside while to fill the gap fresh air is drawn in from outside.

The court yard has become one central element of light in the house. It provides visual access to outside greenery sky and planting space.

Rear space is the only bit of garden left but connected with the rear space of adjoin houses has many layers, including a verandah, tiled roof and large overhang at roof terrace balcony etc which create an intermediate zone in between indoor and out door.

These facilitate the protection from rain and sun as well as provide comfortable shaded and airy outdoor space very apt in tropical climate.

Fig. 37

Rear and front greenery



Fig. 38
Change of light through out the day



Case study two

Residence at Anderson road, Colombo 05 - Designed by Archt. Hitanti Welandawe.

This two storied urban villa is located in plush residential area of Colombo designed by archt. Hiranti Welandawe the house was designed to a well establish Colombo business man who has his roots deep rooted in down south Matara, in spite of his Colombo business life the "village mudalali" character remains still intact and pure.

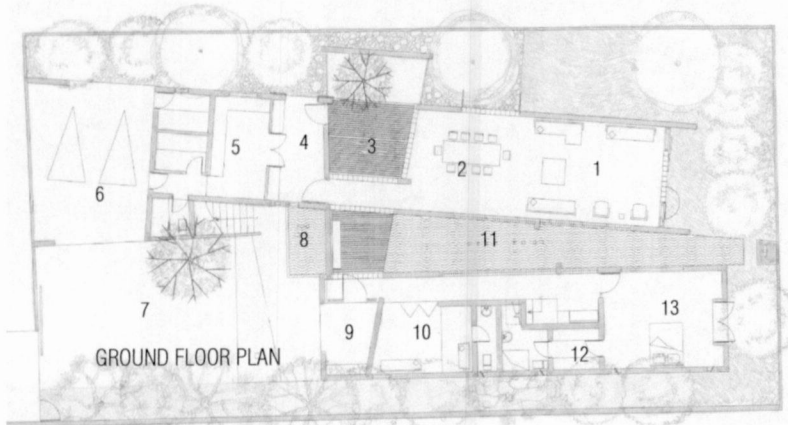


Fig. 39
Entrance Court

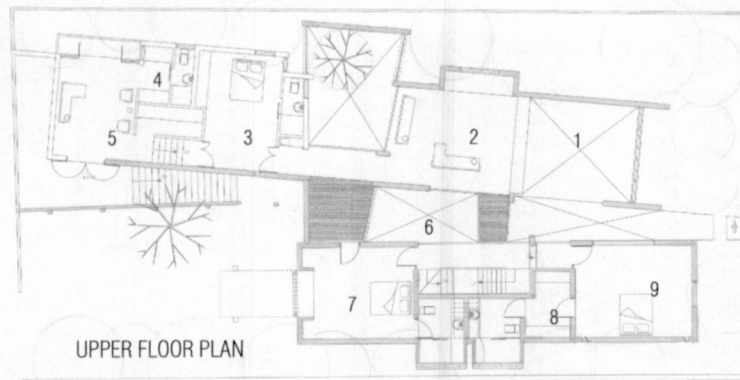
Drawing inspiration from his dwell nature; his pure village character and association of affluent Colombo society, the house was designed to give a feel of grandness and a spaciousness a "Matara walawwa" would have given yet interpreted in a modern terminology to suite his Colombo life. The formation of the design in with two rectangular wings one with a tiled roof housing the living function and a turfed wing housing rooms connected by a linier pool running along the east west direction.



Fig. 40
Court yard & middle pool



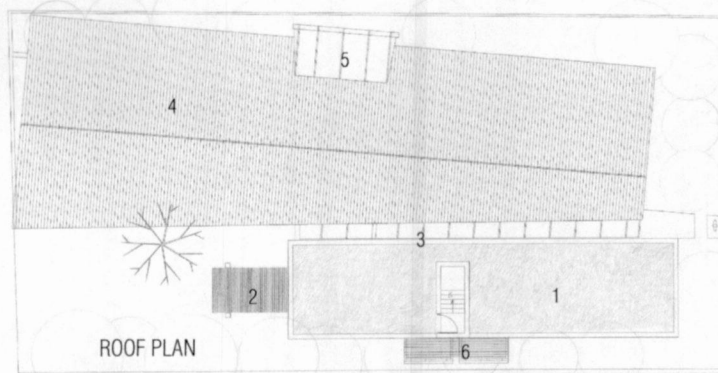
1. living
2. dining
3. courtyard
4. pantry
5. kitchen
6. garage
7. midula
8. pond
9. lobby
10. office room
11. deep pool
12. dressing
13. bed room



1. living below
2. family living
3. bed room
4. pantry
5. living
6. pool below
7. bed room
8. dressing
9. bed room



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1. roof terrace
2. pergola shad
3. glass roof i
4. tile roof
5. glass roof ii
6. shading panels

Fig. 41
Floor plans

The interior of the house has flowing space connecting double height volumes and courtyards creating that lavish grand space for visitors of various levels who come to see him so often. it also has various spaces of varying highrachies to make them comfortable and feel at home. The large kitchen and dining areas accounts for his distinctly sri Lanken knack for hospitality. Therefore this house well suits him in his social interactions and would make him feel at home in his distinctive identity.

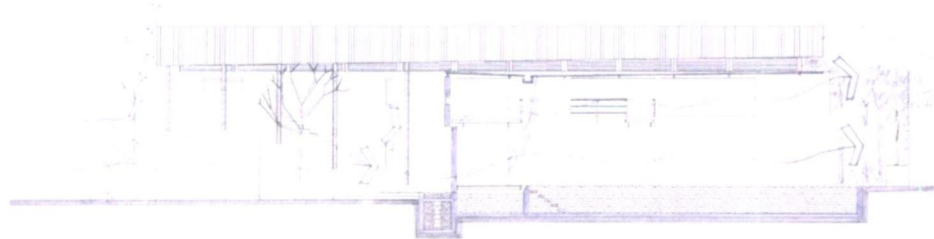


Fig. 42
Section across the pool SECTION THROUGH THE POOL

Further the east west pool accounts for a great cooling mechanism in the house; it is a tow way mechanism. at one hand due to the glass roof on top it draws the heated air up and out of the building with fresh air drawn from outside through courtyard, large windows and vent holes lavishly provided. in the other hand , evaporation of water in the pool creating more comfortable atmospheres.



Fig. 43
Living & upper floor walkway

Fig. 44
Court yard & the garden



The tile roof, planted roof top, turfed gardens, root bawled big trees has almost modified the micro climate producing a more comfortable environment. The orientation of the building is done in such a way the narrow sides of the house facing western and eastern sun at the same time glass roof above the pool becomes the main provider of day light. Therefore the heat absorption surfaces and glair thorough natural light is minimized.



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Conclusion

Urbanity and sustainability were used to be considered as two contradictory concepts which would not go together. But in the olden age, our ancestors has been living in fairly densely polluted, intense, cities, yet going hand in hand with nature. The reason behind this is the wealth of inherent knowledge they had about the overall ecological system, and living accordingly. Therefore like the medieval cities show certain character which is rendered in humble; humanity; which is a one entangled whole with nature. This is the real nature of sustainability. Sustainability is a verge concept, complex and broad .Which is an idea of existence and well being as a whole.

Further it was understood that the process of urbanity could never be curtailed. Man has made the city his main home; due to various attractive it holds him. Along with the populations streaming in to the cities they are found to be the major consumers of the earth's energy and cities have become a symbol of man's dominant presence on earth.

It is being realized that the concept of sustainability has to go hand in hand with urbanity very strictly to retain the ecological balance of the globe. Various gestures supportive of this idea could be seen from overall the world, Auroville India and Curitiba, Brazil, being the hallmark of this consciousness.

Sustainability is a concept of nature, of ecosystems, therefore as any dependence, relationships between spirit and matter, responsibility for consequences and natural energy flows.

Building and constriction has found to be one major aware where there is lot of energy consumption by means of embodied energy, Grey energy, Induced energy, and Operational energy.


Therefore sustainable building design is to curtail on these four means of energy consumption while reinforcing a sense co- existence, interdependence, long-term value, eliminating concept of waste by reuse and recycling and rely on natural energy flows.

The focus of this dissertation has been the urban dwellings and means of achieving sustainability through design and implementation. Therefore the following key factors were considered as main areas.

- Sensitivity to the climate
- Sensitivity to material
- Sensitivity to context
- Respect for user

These were found to be holistic and interconnected decision making an architect should make at the beginning of the design process to create a sustainable building. Further it is would be immensely useful and interesting study are take upon sustainability issues in modern urban design,

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