APPLICATION OF DAYLIGHTING IN THE DESIGN OF NATIONAL ART CENTRE, JOS

BY

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DECLARATION

I declare that the work in the thesis entitled APPLICATION OF DAYLIGHTING IN THE DESIGN OF NATIONAL ART CENTRE JOS has been performed by me in the Department of Architecture under the supervision of Arc. A. O. E Eneh and Arc A. S. Salisu.

The information derived from the literature has duly been acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any university or institution.

Kahu Patience Paul		May, 2012
Name of student	Signature	Date

CERTIFICATION

This thesis entitled APPLICATION OF DAYLIGHTING IN THE DESIGN OF NATIONAL ART CENTRE JOS by Kahu Patience Paul meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

TO GOD ALMIGHTY, MY LATE DAD AND FAMILY

ABSTRACT

Art centres and museums are spaces that house art works and artifact either temporary or permanently. These spaces try to avoid daylight because it has a deteriorating effect on art works and artifacts. Most art centres and museums tend to avoid day light by covering-up spaces and thereby lighting up the rooms through mechanical means.

The purpose of this research is to identify different daylighting techniques that will not affect the exhibition but at the same time, create a good visual experience.

Literatures on daylighting were studied, in which the advantages of daylighting in buildings were highlighted, different daylighting techniques and system were examined and the effects of daylight to art works and artifacts were also studied.

Case studies of relevant museums and art centre buildings were analyzed using appropriate variables. An important finding of the research was that an integrated approach which makes daylighting a primary design consideration is essential for a successful daylighting design process.

This finding affects the design process from site location criteria, site zoning, and building form, choice of materials and most importantly types of daylighting elements to be used.

For the research design, atrium, laminated glass, light shelves and light tubes was appropriate for use. The implication of this finding opens a new dimension to the design of art centres and museums.

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INTRODUCTION

1.1 BACKGROUND STUDY

Humans have unique ways of decoding any incoming information in an environment (stimulus) through perception, memory and judgment. Light can affect our mood, our interpretation of space, and our experience of art. In order for art to be perceived in a stimulating way, the environment must create an adequate reaction. Art appreciation is the knowledge and understanding of the universal and timeless qualities that identify all great art (Phillips, 2009).

Walter (1936) says that art contains aura. This could be described as uniqueness and originality that each piece holds in its physical state. Through design, the passage (allowance) of light helps to allow aura for the art to exist. Not only the allowance of light, but the allowance of climate, can help create this aura within the art piece and the building that contains the piece (Walter, 1936).

The mind perceives natural daylight in its hue or energy, but it is not constantly this way (Phillips, 2009). Light and colour is important to this thesis because they involve methods to alter the sensory environment. According to Mahnke, (1987) these two stimuli (light and colour) do not just illuminate and create a physically pleasant space, but they also affect humans psychologically and physiologically.

Light plays a crucial role in our sensation of space which has been recognized for centuries. Gothic cathedrals are shrines of light and the Baroque produced some of the most dramatic as well as subtle sculpting of surfaces to direct light. This is not simply a matter of letting in sunlight; it is a question as to which surfaces are lit and reflect back light. Kahn (1974) phrased it poetically as ‘the sun never knew how great it was until it struck the side of a building (Johnson, 1975).

Although light can be described as invisible, its effects are palpable and an inseparable component of architecture. As Meier (1987) clearly acknowledged in an interview, 'For me light is the best and most versatile building material'. How light is reflected and what we read into the qualities of that reflected light affects our perception of the solids, of the black lines we draw; immaterial light changes the materials of building. (Brawne, 2003)

When one goes to an art gallery, there exist feelings of a cultural experience because of the absorption of so much information. But could this have been got from the computer at home. Art is not an image experienced in isolation; its habitat also goes a long way in affecting and influencing its perception. Philips (2009) asserted that, one's interpretation or perception of art is imparted by memories and experiences. Art is also more than a vessel for communication, or a mode for imparting experience, art impacts peoples' perceptions and becomes inherent to our psychology (Phillips, 2009). Art can be aided by the design of the building it is housed in. The building should be an extension of the exhibit.

1.2 PROBLEM STATEMENT

Museums and art centres are depository of artifacts and artworks. They have a people's history dating from pre-history to the modern; these are visible and interpreted through the pieces in their collection. These historical objects are displayed in well articulated and organised spaces for the viewing of the public. Consequently, the effect and control of light has a vital role to play on the display of the exhibits.

The problem associated with works of art when unwisely exposed to daylight is a great menace that has lived for years. Due to the problems, most art centres and museums depend on mechanical means of lighting which turns out inadequate especially in cases where power outage is constant. Some museums prefer not to lit exhibition spaces to avoid these problems. Finding a

way to harness the same daylight and use it to lit exhibition spaces without fear of fading and deterioration of exhibits will make the research and design efficient.

The research will set out to employ different methods in the architecture of art centres in order to solve the impending problem of lighting by employing means of cultivating day light to be used efficiently so as to enhance art appreciation.

1.3 AIM AND OBJECTIVES

The aim of this research is the application of daylighting to enhance art appreciation in art centres.

The objectives are;

i. To explore and identify the various types and methods of day lighting strategies that will be suitable in an art centre.

ii. To perform daylight simulation to select suitable daylight strategies.

iii. To apply the result of research conducted in the design.

1.4 RESEARCH METHODOLOGY

In order to ensure a thorough research of the topic, various operational media were employed such as:

1. Case studies

This involves the study of existing facilities to form a basis of identifying existing problems and different methods of applying day lighting in art centres and identify the various ways the design

2. Data analysis and presentation

Data collected on each case study was analyzed and represented in different forms which include:

i. **Photographs**

Pictures of the existing art were taken and documented showing the shopping mall and how the concept of universal design has been reflected; as well as the degree of its application.

ii. **Tables**

Data collected on this research was documented and presented in the universal design case study assessment tables.

iii. **Figures**

Data collected on the case studies was also documented in form of drawings, such as the building's plans.

iv. **Daylight simulation**

This involves predicting, planning and proper design for the impact of daylighting in a space.

1.5 MOTIVATION

The motivation for this research is the worldwide cry to use finite resources wisely and to protect the environment by being as eco-friendly as possible. The built environment contributes a great deal to diminishing the environment. Artificial lighting requires a lot of energy to produce and releases a lot of carbon (4) oxide into the atmosphere. Art centres and museums are illuminated to a large percent by artificial sources of light. Natural or daylight is free and is not hazardous to the environment, thus is eco-friendly. Effectively harnessing it in buildings especially those that use a lot of artificial lighting could be the architects' contribution to alleviating a global problem.

Another source of motivation for this research comes from the desire to explore this area of architecture, which requires understanding of lighting on Artworks in exhibition spaces and how it can be presented to achieve optimum appreciation.

1.6 SCOPE AND DELIMITATION OF THE RESEARCH

This research encompasses the application of day lighting in art centres in Nigeria. Application of day lighting involves the use of design methods, concept in form composition, spatial organization, and use of materials (light), with the aim at applying them to achieve a suitable design solution to meet with the state need.

The scope of the research involves a study of basic requirements for appreciation and smooth functioning of an art centre. Emphasis was focused on applying day lighting which was limited to:

i. An overview of day lighting in buildings.
ii. The advantages of day lighting in buildings.
iii. The contribution of day lighting to interior illuminance through windows, roof lights, atria or light wells and other possible means.
iv. Application in the design.

The proposed location of this facility is in Jos, the capital Plateau state capital. This aims to serve as an avenue for appreciation of Nigerian Art, talent development among children, youth and adult and as a source of revenue.

1.7 JUSTIFICATION

In a specialized and strategic environment dedicated to growth of all forms of art and resources of tourist attraction, there is a need for the budding talents of art in our society, the ever present observers of art and the general public to experience art in its most natural forms.

The architect has a responsibility to find or propose solutions, to reduce the destruction of the environment in order to ensure mans continued existence and comfort. The use of artificial

lighting contributes to this destruction. Therefore if it is possible to reduce the use of artificial lighting and still provide sufficient light for art centres through day lighting systems it is worth researching into and harnessing, especially in regions of the world where the amount of sunlight is relatively constant throughout the year.

CHAPTER TWO

ART CENTRES

2.1 INTRODUCTION

An art centre is a building or buildings used for exhibitions, dramatic productions, music, and poetry readings. It is a place where there is an inextricable link between art and life, and that connections are made through contemporary art which involves visual art and performing art (Sanderson, 2004).

To understand the concept of design of art centre, one must understand the concept of art and art in Nigeria.

1 2.2 ART

Art is the product or process of deliberately arranging items (often with symbolic significance) in a way that influences and affects one or more of the senses, emotions, and intellect. It encompasses a diverse range of human activities, creations, and modes of expression, including music, literature, film, photography, sculpture, and paintings. The meaning of art is explored in a branch of philosophy known as aesthetics, and even disciplines such as history and psychology analyze its relationship with humans and generations (Adajian, 2011).

Traditionally, the term art was used to refer to any skill or mastery. This conception changed during the Romantic period, when art came to be seen as "a special faculty of the human mind to be classified with religion and science". Generally, art is made with the intention of stimulating thoughts and emotions (Adajian, 2011).

The word art can describe several things: a study of creative skill, a process of using the creative skill, a product of the creative skill, or the audience's experience with the creative skill. The creative arts (art as discipline) are a collection of disciplines (arts) that produce artworks (art as objects) that are compelled by a personal drive (art as activity) and echo or reflect a message, mood, or symbolism for the viewer to interpret (art as experience). Artworks can be defined by purposeful, creative interpretations of limitless concepts or ideas in order to communicate something to another person. They can be explicitly made for this purpose or interpreted on the basis of images or objects. Art is something that stimulates an individual's thoughts, emotions, beliefs, or ideas through the senses. It is also an expression of an idea and it can take many different forms and serve many different purposes. Although the application of scientific knowledge to derive a new scientific theory involves skill and results in the "creation" of something new, this represents science only and is not categorized as art.

1.1 2.3 HISTORY OF ART

Sculptures, cave paintings, rock paintings, and petro glyphs from the Upper Paleolithic dating to roughly 40,000 years ago have been found, but the precise meaning of such art is often disputed because so little is known about the cultures that produced them. The oldest art objects in the world is a series of tiny, drilled snail shells about 75,000 years old were discovered in a South African cave (Holly, 2002).

Many great traditions in art have a foundation in the art of one of the great ancient civilizations:

- Ancient Egypt,
- Mesopotamia,
- Persia,

- India,
- China,
- Ancient Greece,
- Rome,
- Inca,
- Maya,
- Omec.

Each of these centres of early civilization developed a unique and characteristic style in its art. Because of the size and duration of these civilizations, more of their art works have survived and more of their influence has been transmitted to other cultures and later times. Some also have provided the first records of how artists worked. For example, this period of Greek art saw a veneration of the human physical form and the development of equivalent skills to show musculature, poise, beauty, and anatomically correct proportions (Holly, 2002).

1.2 2.4 EVALUATION OF ART

The nature of art has been described as "one of the most elusive of the traditional problems of human culture". It has been defined as a vehicle for the expression or communication of emotions and ideas, a means for exploring and appreciating formal elements for their own sake, and as mimesis or representation. Art is the use of indirect means to communicate from one person to another (Tolstoy, 1897).

Collingwood, (1980) advanced the idealist view that art expresses emotions, and that the work of art therefore essentially exists in the mind of the creator.

1.3 2.5 FORMS, GENRES OF ART

- **Art form**

  Is the specific shape, or quality an artistic expression takes. The media used often influence the form. For example, the form of a sculpture must exist in space in three dimensions, and respond to gravity. The constraints and limitations of a particular medium are thus called its formal qualities. To give another example, the formal qualities of painting are the canvas texture, colour, and brush texture. The formal qualities of video games are non-linearity, interactivity and virtual presence. The form of a particular work of art is determined by the formal qualities of the media, and is not related to the intentions of the artist or the reactions of the audience in any way what so ever. (Danto, 2003)

- **Genre**

  Is a set of conventions and styles within a particular medium. For instance, well recognized genres in film are western, horror and romantic comedy. Genres in music include death metal and trip hop. Genres in painting include still life and pastoral landscape. A particular work of art may bend or combine genres but each genre has a recognizable group of conventions, clichés and tropes. (Danto, 2003)

2.6 SCHOOLS OF ART

A "school of art" is a group of people who have done similar types of art during a period of history. They do not work in any school or place together, usually, and often they are not even found in the same city or state. They just happen to be working with similar types of mediums, subjects, styles, or plans such that they somehow can be fitted together as a single group (Jewell, 2002).

It is not important to know all of them. Knowing just a few of the major schools is enough to get a sense of the diversity and importance of visual arts.

i. **Abstract expressionism**

This school of artists likes to express emotion through color and abstract form. Abstract expressionists dominated the American art scene in the 1950s. Abstract painters such as Kandinsky and Jackson Pollock were part of this movement. (Tationa, 2011)

ii. **Baroque**

Baroque arts were popular in the seventeenth century and made use of dramatic scenes and characters, especially religious subjects. There were scenes of religious ecstasy and hellish despair, martyrdom, and conversion, with strong coloring and dramatic dark-light combinations of shading. (Tationa, 2011)

iii. **Classicism**

A classicist is an artist who creates like the Greeks and Romans did--with clear, simple, realistic lines, not emotionally but calmly and with reason, in an orderly, restrained, careful manner. (Tationa, 2011)

iv. **Cubism**

Cubist painters show the front, back, and sides of a subject at the same time in geometric patterns. All sides of the "cube" of space in which the subject rests are shown. Picasso and Braque made cubist paintings and etchings. (Tationa, 2011)

v. **Expressionism**

There are two meanings for this word. The main meaning is a general one: art that is emotional, intense, and passionate. Expressionist art often uses intense color and presents disturbingly strong feelings. Such painters as Van Gogh and El Greco both are

expressionistic. A second meaning of "expressionism" is a particular school of the arts, German expressionism, from the early part of the twentieth century. (Tationa, 2011)

vi. Fauvism

A small school of art that is similar to expressionism in that it encouraged intense colors, free form, and a strong decorative affect. The French painter Matisse was a fauvist. (Tationa, 2011)

vii. Geometric abstraction

This kind of art shows pure geometric forms and colors that often look, on canvas, like black-lined "windows" with colorful top, bottom, and side panels. Mondrian was one such painter. (Tationa, 2011)

viii. Impressionism

Impressionists tend in our time to be among the most popular painters. They worked mostly in the late nineteenth and early twentieth century's. Names like Degas, Renoir, Manet, and Monet (and in music Debussy and Ravel) are almost as recognizable to many people as the type of art they produced: vivid slice- of-life visual scenes that shimmer and dance with light and color, air, water, and land. (Tationa, 2011)

ix. Minimalism

In the visual arts, this has represented a movement in the mid-twentieth century to reduce painting to the minimum of elements: abstract geometric lines and basic colors. (Tationa, 2011)

x. Naturalism

Naturalist painters of the twentieth century tried to show an almost photographic likeness

of reality--all the details the eye might see from the given distance. Manet, Degas, and Harnett were naturalists. (Tationa, 2011)

xi. Op art

Op art was a major art movement in the 1960s. Op artists show vivid, visually stimulating geometric forms and colors that repeat themselves, much like computerized geometric pattern drawings, overloading the senses and sometimes creating illusions. (Tationa, 2011)

xii. Photo realism

Photo realism or "new realism" painters of the 1970s paint slice-of-life photos with great detail and with an emphasis of light or color of certain objects. We thus see reality in a new way, through the eyes of the artist, noticing things he or she sees but we don't. Often the new things we see are not pleasant. (Tationa, 2011)

xiii. Pointillism

Pointillists worked in the early twentieth century. When one stands close to a pointillist painting, all one sees is dots of color. But when one stands back, the colors blend together in the eye to create an unusually precise, almost vibrating scene. Seurat and Monet were pointillists. (Tationa, 2011)

xiv. Pop art

Pop art often tries to reproduce objects-- especially advertising objects--accurately. Andy Warhol's paintings of Campbell's Soup cans and of Marilyn Monroe are good examples, as are the works of Roy Lichtenstein. (Tationa, 2011)

xv. Postimpressionism

Many artists in the early and middle twentieth century used impressionist painting styles

to develop further styles. Impressionists tried simply to show what the eye sees; postimpressionists also wished to convey some deeper personal message or meaning. (Tationa, 2011)

xvi. Realism

Realists, twentieth-century painters, created scenes that were easily recognizable or realistic, and also showed the subject in both its attractive and unattractive lights. Realists, for example, might paint a scene of urban life that shows homeless and wealthy people side by side. (Tationa, 2011)

xvii. Romanticism

Romantic painters paint joy, fear, anger, pride, hurt, and love. They prefer emotion to reason, freedom to constraint, and the personal to the universal. Romanticism is a self-expression movement in the arts. Romantic art makes strong, personal statements. (Tationa, 2011)

xviii. Street art

This can signify graffiti, murals painted by community members on community walls, or gang-related logos and messages painted symbolically. The term usually designates that the art is of or on the "street"; it comes out of an urban working class or poor environment and the artists have not had formal training. (Tationa, 2011)

xix. Surrealism

A mostly European between-world-wars art movement, surrealism emphasized dreamlike reality, full of mysterious symbols and meanings. Salvador Dali is a well-known example of surrealism. (Tationa, 2011)

1.4 2.7 CHARACTERISTICS OF ART

Art tends to facilitate intuitive rather than rational understanding, and is usually consciously created with this intention. Fine art intentionally serves no other purpose. As a result of this impetus, works of art are elusive, refractive to attempts at classification, because they can be appreciated in more than one way, and are often susceptible to many different interpretations. (Davies, 1991)

2.8 PURPOSE OF ART

Art has had a great number of different functions throughout its history, making its purpose difficult to abstract or quantify to any single concept. This does not imply that the purpose of Art is "vague", but that it has had many unique, different reasons for being created. Some of these functions of Art are provided in the following outline. The different purposes of art may be grouped according to those that are non-motivated, and those that are motivated. (Iverson, 2003)

i. Non-motivated functions of art

The non-motivated purposes of art are those that are integral to being human, transcend the individual, or do not fulfil a specific external purpose. Aristotle said, "Imitation, then, is one instinct of our nature." In this sense, Art, as creativity, is something humans must do by their very nature (that is, no other species creates art), and is therefore beyond utility. (Iverson, 2003)

- **Basic human instinct for harmony, balance, and rhythm**

Art at this level is not an action or an object, but an internal appreciation of balance and harmony (beauty), and therefore an aspect of being human beyond utility.

"Imitation, then, is one instinct of our nature. Next, there is the instinct for 'harmony' and rhythm, meters being manifestly sections of rhythm. Persons, therefore, starting with this

natural gift developed by degrees their special aptitudes, till their rude improvisations gave birth to Poetry." –Aristotle.

- **Experience of the mysterious**

  Art provides a way to experience one's self in relation to the universe. This experience may often come unmotivated, as one appreciates art, music or poetry. (Iverson, 2003)

  "The most beautiful thing we can experience is the mysterious. It is the source of all true art and science." -Albert Einstein.

- **Expression of the imagination**

  Art provide a means to express the imagination in non-grammatical ways that are not tied to the formality of spoken or written language. Unlike words, which come in sequences and each of which have a definite meaning, art provides a range of forms, symbols and ideas with meanings that are malleable. (Iverson, 2003)

  "Jupiter's eagle [as an example of art] is not, like logical (aesthetic) attributes of an object, the concept of the sublimity and majesty of creation, but rather something else – something that gives the imagination an incentive to spread its flight over a whole host of kindred representations that provoke more thought than admits of expression in a concept determined by words. They furnish an aesthetic idea, which serves the above rational idea as a substitute for logical presentation, but with the proper function, however, of animating the mind by opening out for it a prospect into a field of kindred representations stretching beyond its ken." - Kant, (1790).

- **Universal communication**

  Art allows the individual to express things toward the world as a whole. Earth artists often create art in remote locations that will never be experienced by another person. The practice of placing a cairn, or pile of stones at the top of a mountain, is an example. Art created in this way is a form of communication between the individual and the world as a whole. (Iverson, 2003)

- **Ritualistic and symbolic functions**

  In many cultures, art is used in rituals, performances and dances as a decoration or symbol. While these often have no specific utilitarian (motivated) purpose, anthropologists know that they often serve a purpose at the level of meaning within a particular culture. This meaning is not furnished by any one individual, but is often the result of many generations of change, and of a cosmological relationship within the culture. (Iverson, 2003)

"*Most scholars who deal with rock paintings or objects recovered from prehistoric contexts that cannot be explained in utilitarian terms and are thus categorized as decorative, ritual or symbolic, are aware of the trap posed by the term 'art'.*"

-Silva Tomaskova

ii. Motivated functions of art

Motivated purposes of art refer to intentional, conscious actions on the part of the artists or creator. These may be to bring about political change, to comment on an aspect of society, to convey a specific emotion or mood, to address personal psychology, to illustrate another discipline, to sell a product, or simply as a form of communication. (Iverson, 2003)

- **Communication**

  Art, at its simplest, is a form of communication. As most forms of communication have an intent or goal directed toward another individual, this is a motivated purpose. Illustrative arts, such as scientific illustration, are a form of art as communication. Maps are another example. However, the content need not be scientific. Emotions, moods and feelings are also communicated through art. (Iverson, 2003)

"Art is a set of artifacts or images with symbolic meanings as a means of communication." -Steve Mithen

- **Art as entertainment**

  Art may seek to bring about a particular emotion or mood, for the purpose of relaxing or entertaining the viewer. This is often the function of the art industries of Motion Pictures and Video Games. (Iverson, 2003)

- **The Avant-Garde**

  One of the defining functions of early twentieth century art has been to use visual images to bring about political change. Dadaism, Surrealism, Russian Constructivism, and Abstract Expressionism, among others are collectively referred to as the avant-garde arts.

- **Art for psychological and healing purposes**

  Art is also used by art therapists, psychotherapists and clinical psychologists as art therapy. The Diagnostic Drawing Series, for example, is used to determine the personality and emotional functioning of a patient. The end product is not the principal goal in this case, but rather a process of healing, through creative acts, is sought. The resultant piece of artwork may also offer insight into the troubles experienced by the subject and may suggest suitable approaches to be used in more conventional forms of psychiatric therapy. (Iverson, 2003)

- **Art for social inquiry, subversion and/or anarchy**

  While similar to art for political change, subversive or deconstructivist art may seek to question aspects of society without any specific political goal. In this case, the function of art may be simply to criticize some aspect of society. Graffiti art and other types of street art are graphics and images that are spray-painted or stencilled on publicly viewable walls, buildings, buses, trains, and bridges, usually without permission. Certain art forms, such as graffiti, may also be illegal when they break laws (in this case vandalism). (Iverson, 2003)

- **Art for propaganda, or commercialism**

  Art is often utilized as a form of propaganda, and thus can be used to subtly influence popular conceptions or mood. In a similar way, art that tries to sell a product also influences mood and emotion. In both cases, the purpose of art here is to subtly manipulate the viewer into a particular emotional or psychological response toward a particular idea or object. (Iverson, 2003)

2.9 NIGERIAN ART

2.9.1 Historical overview of Nigerian arts

The history of Nigerian art rightly put by art historians dates back into time. Art in Nigeria has found expression in a range of media from architecture, sculpture, and pottery, to dress, body adornment, music, dance, drama and epic poetry (Nketia, 2003)

Each of these has its own complexity and in many cases unrehearsed local history of stylistic development. Also, the arts tradition in Nigeria with individual styles include those of the Yoruba, Edo, Igbo, Ibibio, Ijaw, Ogoja, Nok, Hausa and history of other groups of people.

History has it that the operations in the deep tin mining areas of Jos, Plateau State, revealed the first evidence of an ancient sculptural tradition in terracotta that forms part of the cultural context, known as Nok culture, dated between 900BC and AD 200 in 1938some intricately

executed bronze works were discovered in the small villge of Igbo Ukwu near Akwa, east of the river Niger (Nketia 2003).

Also, in the Yoruba city of Ile-Ife, a German ethnologist found terracotta and bronze sculpture executed in a naturalistic style in 1910. This led to systematic excavations in the city from 1934 onwards, revealing a great quantity of sculpture which was made on present evidence, between 12^{th} to 15^{th} centuries A.D.

Another accidental discovery of fragment of terra cotta sculpture, led to the systematic excavation of a site, in Owo, which revealed the co-existence of two art styles; those of Ife and Benin. This site has been dated by scientific means to the early 15^{th} century. The Benin has a lot of ancient artwork that has become famous over different parts of the world, and they can be seen in museums around the world. Alongside these trends in sculpture were various creations in textiles, painting and craft (Nketia 2003).

Skinner, (1989) concluded that, "Nigeria art is attractive because of its powerful emotional content and its beautiful abstract forms. The Nigerian Art is functional; its function being the purpose for which it was created whether socially, economical, political or religious"

Thus, art in Nigeria is more of a concept of communal life as compared to the individual expressions seen in most foreign, especially western Artist. To Nigerian artist, community existed prior to the individual and the individual is just a small part of a long tradition. (Nketia 2003).

2.10 ART IN NIGERIA

Although "art" is a foreign word to many Nigerian groups, its objects and meanings are not. Examples of art include tools, weapons, utensils, musical instruments, carved doors, house posts,

and various sculpted masks and items used for social and religious ceremonies. The most common art productions in Nigeria include rock paintings and engravings; decorated pottery; sculptural representations in bronze, clay, stone, wood, and ivory; and ornate forms of decoration. (Nzewi, 2005)

Objects of art reveal the level of specialization in the country, the dedication of time and energy to creating them, and the number of people making a living as artists or working in media organizations. Many young people go to formal schools to study various art media, while others serve as apprentices to traditional wood-carvers, leather workers, or gourd decorators. (Nzewi, 2005)

Art appreciation provides people with leisure activity as they visit museums and monuments. Furthermore, it contributes to modern living and the economy, as people decorate homes and offices with artwork. Traditional and modern forms coexist and are also combined as elements of creative modern art. The religious significance of art continues to be maintained as important objects are utilized in indigenous and other religious rituals, as in the public display of masks in masquerades, and in the ornamentation of churches. (Phillips, 2009)

Nigerian and African art is not limited to wood sculpture, which is the form generally displayed in Western museums and often appearing on the covers of books and magazines on Africa. The genres and forms are multiple and diverse, each having traditional and modern styles, reflected in architecture, body adornments, and the various performances associated with religion, law, agriculture, and other ceremonies. (Nzewi, 2005)

2.11 NIGERIAN TRADITIONAL ART

About a decade ago, Nigeria mounted a travelling art exhibition titled "Treasures of Ancient Nigeria," which lured the United States of America, Canada, Britain and some European countries for more than three years. Critics described the exhibition as the best and most comprehensive to come from Africa. The art works represented the vintage of Nigerian artistic expression, for included in the show, were the bold and imaginative Nok terra cottas, described as the oldest sculptures in Africa South of the Sahara, the bronze and terra cotta heads of lfe which represent a naturalism comparable to that of classical Greek sculpture, the famous heads, figurines and plaques from the foundries of the ancient city of Benin and the lgbo-Ukwu bronzes described as among the earliest bronze works created by Nigerian craftsmen (Wangboje, 2011).

Wangboje, (2011) revealed that significance of Nigerian traditional arts was not revealed to the outside world until after the Second World War when systematic study and analysis mostly by European and American scholars were undertaken. Prior to this and even though Nigeria's contact with Europe dates from the fifteenth century, very little was known about Nigeria's artistic heritage until 1897 when a British Punitive Expedition not only sacked the ancient city of Benin but also removed as 'War' booty several thousand art works, mostly in bronze, from the Oba's palace. These works, the first African art to be accorded world recognition, remain today the most famous of all African traditional sculptures. A recent writer high lights the dispersal of these works when he writes: *"the last place to go if you want to see Benin art is Benin itself, very little of it is left in the city (Legum, 1960).*

Nigerians have always used art as a means to play and to embody shared communications. There are musical instruments to facilitate song and dance. Masks and other objects are used to

enhance performances. Various games carved from wood (such as *ayo* among the Yoruba) facilitate leisure. There are artists who make toys for children, such as the *omolangidi* (carvings in the image of humans and animals) of the Yoruba. In general, traditional art tends to radiate energy outward, which lends itself to play and communication. The making of a mask may be a contemplative exercise, but its use is directed outward.

Thanks to efforts at preservation and adaptation, traditional art is very much alive in a variety of ways: bronze casting, wood carving, and painting. By and large, concerns with aesthetics now overshadow objects' ritual and religious significance. Contemporary kings and court officials have revived the custom of commissioning bronze workers, wood-carvers, and bead and crown makers to supply objects of royalty that they continue to use as symbols of power and prestige. The Catholic mission has a proud history of encouraging local artists, especially in wood carving. There is also a foreign market and a growing number of Nigerian educated elite for which traditional artists produce (Wangboje, 2011).

Nigerian Traditional crafts can be found everywhere, in cities and villages alike. They include the making of domestic utensils, such as cooking pots and serving spoons, furniture, and decorative items. These days, materials may not be wholly local: for example, the yarns and dyes for local cloths can be imported; and the thread and materials for hairstyling can come from local or foreign sources. In the areas of fashion and hairstyling, the elite do consume products of local crafts but local products, especially domestic utensils, are used with more frequency in rural areas.

Producers of traditional arts and crafts are underpaid and undervalued simply because they lack sufficient numbers of patrons with money. While the techniques of production are integrated into

some school curricula, not many students develop an interest in them. Nevertheless, traditional art has endured a century of great changes and many of its aspects have been carefully integrated into modern art. The types of traditional art in Nigeria are:

2.11.1 The Nok terras:

Consisting of human and animal figures and believed to have been made between 500 BC and 200 AD are reputed to be the oldest sculptures in Africa, South of the Sahara. Like most other African traditional art forms, the Nok terra cottas were of religious and social signifi cance. Although considerable archaeological work remains to be done in order to establish the extent of Nok influence in other West African sculptures, it has been fairly established that the culture that produced the terra-cottas had a substantial influence in later sculptures that developed in West Africa and Nigeria in particular, the art of lfe, Benin and Owo have been cited as clear examples. The discovery of Nok art is important in the history of African art because it brought about a change in previously held view that the oldest African traditional sculptures were only a few hundred years old. Identified by Bernard Fagg in 1943, the culture which produced this art has shed new light on the achievement of the people who are believed to have known how to work in iron, using indigenous technology, as revealed by large quantities of iron artifacts. A study of the terra-cottas and associated artifacts indicates that the Nok culture is in many ways similar to that of the present inhabitants of the same area (Wangboje, 2011).

2.11.2 lfe Art:

lfe art has been acknowledged as the most famous manifestation of naturalism in African art and so startled the Western world on its discovery at the early part of this century that the works were

thought to be beyond the capabilities of Africans. In fact, the German explorer and ethnologist, Leo Frobenius, who carried out the first excavation at lle-ife (1910-12), thought that the bronzes and terra cottas were the works of itinerant European artists. This view remained current in European circles until the discovery of more terra cotta and bronze figures in lfe by other archaeologists which established beyond doubt that the lfe style was the peak of an earlier naturalistically inclined art form that flourished further north during the Nok culture (Wangboje, 2011).

2.11.3 lgbo-Ukwu Bronzes;

The latest finds in this line of artistic achievements are the lgbo-Ukwu bronzes - (excavated by the archaeologist Thurston Shaw in the present Anambra State). Made up of bowls pots, staff heads and bracelets, the origin of these works is yet to be firmly established but what is certain is that they are among the earliest works created in bronze, having flourished between 600 and 1000 AD.

Less widely spread but still of great-significance is the sculptures in stone and wood such as the Ikom monoleths and the famous Oron-Ekpu wood carvings.

Several other art styles of historical importance developed in various parts of Nigeria. Of these, a group of very sophisticated soap-stone figures, the single largest in Africa, was discovered at Esie in Kwara State. They are believed to be the works of Nupe people who still inhabit the area.

Cordwell, (1959) refers to them as exhibiting a "combination of naturalism and stylised proportioning" and sharing some affinity with the art of Nok, lfe and Benin. (Cordwell, 1959).

1.4.1.1 2.12 CONTEMPORARY NIGERIAN ART AND FORMS

Contemporary art has been driven by the need, first, to retain the essence of traditional art; second, to blend traditional art with modern; and third, to create abstract works. While modern artists borrow tools and techniques from different parts of the world, many among them still talk of the need to preserve African artistic traditions, retain Nigerian identity, and project an "African personality." Traditional art, modern two-dimensional art, sculpture, painting, architecture, graphics, textiles, and fashion designs are among the most popular art forms. As in other aspects of Nigerian culture and customs, the arts have had to respond to the spread of Islam and Christianity, the imposition of colonial rule, and the rapid spread of Western culture (Ola, 1996).

Thus it can be deduced that arts in Nigeria tends to evolve from an organic standpoint making it dynamic giving rise to various distinct form practiced throughout the land till date. The various forms of Nigerian art are;

i. **Visual arts:** This aspect of art is mostly associated with painting, drawing, sculpture, photography, ceramics, textile, glass, metal work, wood work, graphics and craft. Visual art is based on aesthetic objects, which can be static, dynamic, temporary or even permanent and is best appreciated visually such as Plate 2.2 and plate 2.1.

ii. **Performance art:** This aspect of art s in Nigeria continues to generate public interest. Performance art in its diverse context involves dance, music, comedy, theatre, film and spoken word. Plate 2.3 and plate 2.4 shows a good illustration of performance art.



Plate 2.1; textile art in Nigeria

Source; Nike art and culture (2010)

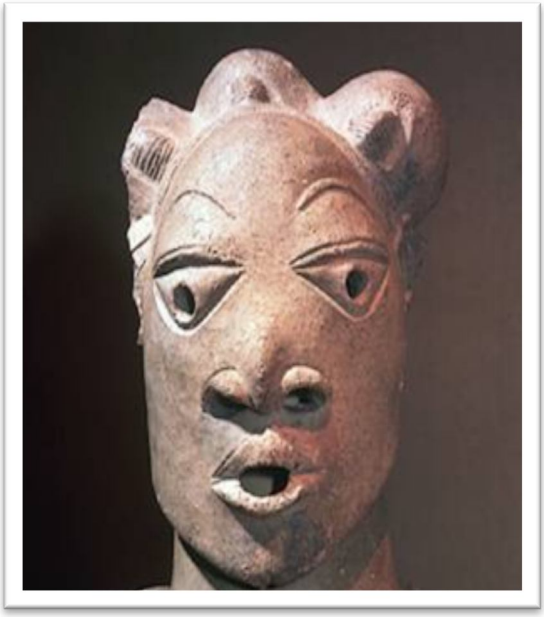


Plate 2.2; Nok art

Source; Cynthia Becker (2009)



Plate 2.3; Nigerian dancers performing on stage

Source; www.googleimages.com (2011)



Plate 2.4; Nigerian dancers performing on stage

Source; www.googleimages.com (2011)

iii. Literary art: The literary aspect of art in Nigeria involves journalism, novel presentation, oral narratives, periodicals, poetry, and scholarly write-ups. Literature typically followed an oral tradition in Nigeria, like it did in other parts of Africa. However, presently Nigerian literature has gained wide popularity not only within the country, but internationally (Ola, 1996).

2.13 NATIONAL COLLECTION OF CONTEMPORARY ART IN NIGERIA

There is collections of contemporary works by both government's culture institutions and private

collectors. The institution charged with the national collection of contemporary art is the National Gallery of Art NGA. It has the largest collection of artists' works among the other culture institutions created. Its collection was first documented in 1981 in a publication titled "The Nucleus". There are also private galleries and collectors who have in their keeps works of prominent contemporary artists. Among the private galleries in Lagos are Signature gallery, Treasure House, Nimbus gallery, Mydrim gallery, Galleria Romania, Nike Okundaye gallery, Quintessence and others. Private collectors are few Nigerians and foreigners mostly Europeans and Americans who have in their collections works of most artists mentioned in this article. Of special note among the Nigerian collectors, is Engineer Yemisi Shyllon, an avid art collector who arguably has the largest private collections of contemporary artists' works both Nigerian and non-Nigerian artists.

2.14 EARLY TREND IN DESIGN OF ART CENTRE

The architectural form of the art gallery and exhibition spaces was established by Sir John Soane with his design for the Dulwich Picture Gallery in 1817. This established the gallery as a series of interconnected rooms with largely uninterrupted wall spaces for hanging pictures and indirect lighting from skylights or roof lanterns. In the early architecture, art centers of roman empires, Mesopotamians, Asians and Africa was a big hall like the coliseum and basilicas in Rome. Later there was a development of art galleries (Fletcher .B. 2006). .

In the post-napoleon wars, they existed as separate units like the visual art galleries and performing art theatres, opera, museum and concert halls. They were mostly well decorated and ornamented and decorations exhibited on walls and cathedrals like works of Leonardo da Vinc (Fletcher .B. 2006). One of the most remarkable museum that existed is the State Hermitage

Museum (Gosudarstvenny Ermitazh Muzey) which is virtually wallpapered with celebrated paintings.

1.5 In addition, the walls are works of art themselves, for this collection is housed in the lavish Winter Palace, one of the most outstanding examples of Russian baroque magnificence. The museum takes its name from Catherine the Great (1729-96), who used it for her private apartments, intending them to be a place of retreat and seclusion. "Only the mice and I can admire all this," the empress once declared. Between 1764 and 1775, the empress undertook, in competition with rulers whose storehouses of art greatly surpassed Russia's, to acquire some of the world's finest works of art. In doing so, sometimes acquiring entire private collections outright, she quickly filled her gallery with masterpieces from all over the world. This original gallery section of the Hermitage, completed in 1770 by Vallin de la Mothe, is now known as the Maly (Little) Hermitage (Fodor, 2011). It's attached to the Stary (Old) Hermitage, which was built in 1783 by Yuri Felten to house the overflow of art, and also contained conference chambers for the tsarina's ministers.

2.15 CURRENT TREND IN THE DESIGN OF ART CENTRE

Study has provided information from literature and publications that in the recent architecture there has been a trend which classified the growth or emergence of art centers into three (3) broad categories

- The theatre and performing art center
- Visual art centers, museums and galleries
- Hybrid of the two above

"Today, museums are busier and more exciting and attractive." Says Arthur Rosenblatt,

(Metropolitan Museum of Art) Also pointed in the same article are "7 New Trends in Museum Design."

1. Museum structure as artwork and attractor,
2. Greater emphasis on retail space and restaurants,
3. Grand halls for hosting events,
4. Flexible gallery space for travelling exhibits,
5. More outdoor art and landscaping,
6. Hardwiring for technology,
7. Parking becomes a top priority.

The points describe positive directions architecturally, socially, and economically in museum construction. (Flynn, 2002)

2.16 CONTEMPORARY ART CENTER IN NIGERIA

The centers for contemporary arts in Nigeria outside of the Lagos gallery scene are now in Nigerian universities, colleges of education and technical colleges where majority of the Artist are located. Therefore, the need to break this monopoly stems in provision of centers of contemporary arts outside the confines of the academic environment. For this movement of art to gain considerable level play ground, there is the need for the public to be sensitized. From a humble beginning came the evolution of contemporary arts in Nigeria.

2.17 CONCEPT OF CONTEMPORARY ART CENTRE

The concept of contemporary arts in a multi-disciplinary arts centre, intended to be financially stable and professionally managed, dedicated to the presentation, production and promotion of art of our time. Accomplishing this task will entail organizing curated exhibitions, performances and programs; enlarging audiences; and encouraging collaboration among diverse artists, institutions, communities and supporters. The centre is also envisage to be a cultural arts centre,

nationally recognized as a leader in the presentation and support of modern and contemporary arts, artists and emerging art forms. An avenue for Artist to boldly experiment their creative potentials in painting, theatre, photography, performance art, dance, music, video, education and sculpture. Additionally, it is intended that local performers through this centre will avail themselves the opportunity of staging plays, dance events, music concerts and performance within the facilities provided.

2.18 PIONEERING ART CENTERS IN NIGERIA

The growth of contemporary arts in Nigeria no doubt owes credit to the various arts tents in the so termed regions of the country in the early years after independence. The growth of this cultural art institution against the backdrop of colonialism influenced the birth of a more tardy culture which continues to generate attention to thrive. The schools or rightly put art centers are;

i. Zaria art school

The works of the school are characterized by elongation of forms, with elegant northern architecture and human figures. Their landscapes, most times reflect the grassland and savannah vegetation of the North. Other later graduates of the Zaria School who have made their marks from 1950s till date as artists, teachers and historians include Prof. Yomi Adetoro, Dr. Tunde Akinwumi, Jerry Buhari, Jacob Jari, Tonie Okpe, Rukeme Noserime, Nse-Abasi Inyang, Tunde Balogun, Tunde Oniyide, Tony Emordi, Victoria Ukpera, Chinwe Abara, Abraham Uyobusere, Akeem Balogun, Wunmi Busuyi, Betty Bassey, Duke Asidere, Emmanuel Irokanumo, Ade Odun, Taiwo Oyejide and Abiola Idowu among others. Their contributions have been in the sustenance of the art tempo which the pioneers started through their constant practice. While some of the listed artists

are household names among the art historians, critic, collectors and the art audience, some talents are just emerging. (African Artist, 2009)

ii. Yaba School

The Yaba School employs realistic art form that is done in narrative, and descriptive style mostly done in accurate photo-graphic-realism. The initial notable artists who graduated in the 50s and 60s and went for higher studies in Europe include Agbo Folarin, Isiaka Osunde, and Abayomi Barber. The later artists of the School, who were taught by the former graduates of the Zaria School, belong to the 1980s generation. These include Mike Omoighe, Biodun Olaku, Phemi Adeniran, Lara Ige, Felix Osieme, Edosa Oguigo , Joe Amenechi, Ato Arinze, Sam Ebohan among others. (African Artist, 2009)

iii. Nsukka School

The calligraphic nature of 'Uli' art body painting/decoration influenced the products', works. The philosophy of application of Uli art form as espoused by Uche Okeke and later supported by Chuka Amefuna, Chike Aniakor and El-Anasui was to intensify the search for Igbo–identity, thereby using the Uli linear forms to depict radical socio-political and cultural subject matters. Their linearity of drawing and modeling according to Filani, became the hall mark of Nsukka's contribution to modern Nigerian art. The graduates are conceptually rich and fecund in imagination thereby making their themes to penetrate into the social situations of the people. (African Artist, 2009)

iv. Ife School

The school is noted with intellectualization of its works with vigorous emphasis on theoretical content in art form. Noted with cultural inspiration drawn from the Ife location, the school explores a rather diversity of creative exploration in the use of local

materials, symbols and images which later developed into the exploration of Yoruba traditional symbols, motifs, structure and concepts termed Ona by some of the 1980s graduates. The lecturers of the Ife School who are not graduates of the school include Babatunde Lawal, J.R.O Ojo, Abiodun Rowland, Ige Ibigbami, Agbo Folarin and PSO Aremu among others. (African Artist, 2009)

v. Auchi School

Auchi Art School is noted with expressionistic naturalism. The use of vibrant and sweet colours is attributed to the graduates of the school. Some of the outstanding artists of the school who have made their impact on the audience and collectors include Ben Osaghae, Sam Ovraiti, Olu Ajayi, Pita Ohiweri, Edwin Debebs, Alex Nwokolo, Toni Oshiame and Olu Amoda metal sculptor among others. (African Artist, 2009)

vi. The informal schools

These are art locations where artists are informally trained without following rigid rules of formal art syllabus. The training is acquired through apprenticeship system or workshop experience. Within the informal school, some of them do not obey the rules of accurate proportion, and perspective. Mbari Mbayo–Osogbo and Ori-Olokun-Ife schools explored the workshop system. Notable artists that emerged from the Osogbo School include Twin Seven Seven, Jimoh Buraimoh, Muraina Oyelami, Tijani Mayakiri, Rufus Ogundele, Ademola Onibonokuta, Asiru Olatunde, and Nike Davies. Their contributions to art history in Nigeria are their deviation from the known western–style realistic form. These artists' forms are original, spontaneous and naively created with utter disregard for the depth, space or any expected relationship of motif. Their themes are most times derived from folktales, myths and religious stories such as the characteristics of which

was classified as "Naive Vision encouraged and fossilized" Adepegba, 1995. They hardly follow the cannon of verisimilitude which is common with Western Art. (African Artist, 2009)

vii. Aka group

Aka Group based in Enugu and Nsukka in the Eastern part of Nigeria, formed in 1989 as a circle of exhibiting artists. It has close affinity to Nsukka School. As reported by Filani, (1998:41) the Aka group and Uli artists are philosophically inclined in thematic choice with clairvoyance in social vision. (African Artist, 2009)

viii. Eye Society

The Eye society is based in Zaria Ahmadu Bello University. It was formed in 1992. The membership comprises mainly some artist staff of the Department of Fine Arts of the University who also graduated from the Department. Some of the founding members include Gani Odutokun died in 1994, Jerry Buhari, Jacob Jari, Matt Ehizele and Tonie Okpe. The group's contributions have been in the areas of propagation of visual arts as an instrument of development of the society, publishing of journal called "The Eye", mounting of exhibitions, organizing workshops conferences and symposia. (African Artist, 2009)

ix. Uli Movement

It is Nsukka-based. The membership is for an artist who believes in the philosophy of Uli Art as a stylistic expression using its linear and spiral motifs in terms of forms and using themes that have socio-cultural content and advantage. (African Artist, 2009)

x. Ona Movement

This was formed in 1990 by the five graduates of "Ife Art School". The five pioneering

founding members include Kunle Filani, Moyo Okediji, Tola Wewe, Bolaji Campbell and Tunde Nasiru. The movement explores the decorative motifs, ornaments, patterns and design peculiar to the rich artistic culture of the Yoruba Filani 1998. One advantage of Ona approach to artistic expression according to Filani, (1997) is the rich visual grammar it affords the artist to employ, resulting to melody of tones, forms and structure and also enriching the aesthetic sensibilities of the viewers Filani (1997). One of the major contributions of Ona movement to contemporary art is its enriching the visual aesthetic and appreciation of Art.

xi. Pan-African circle of artists (PACA)

1.5.1 It is an artists' organisation formed in 1995. Its focus is to provide fora or avenues for African artists within and outside the Continent. It also works "at engineering an indigenous voice for the propagation of African Art" Ikwuemesi, (2000). Its founding members include Krydz Ikwuemesi, Ayo Adewumi, Nnaemeka Egwuibe, Jerry Buhari etc. One other contribution to art history in Nigeria and African continent is its regular publications that border on African and global issues. Its headquarters is located in Enugu, Nigeria. (African Artist, 2009)

1.5.2 Xii. Culture and creative art forum (CCAF)
This organization was formed in July, 2001. Its objectives among others include intervening and promoting the creative and artistic education of Africans through cultural means in order to encourage their economic and creative independence. It is also to maintain and sustain the rich cultural heritage of Africa and her people. Its headquarters is located in Lagos, Nigeria. (African Artist, 2009)

CHAPTER THREE

DAY LIGHTING

3.1 INTRODUCTION

This chapter will deal on daylighting, its means of transmission, its problems, control and application in buildings.

3.2 DAYLIGHTING

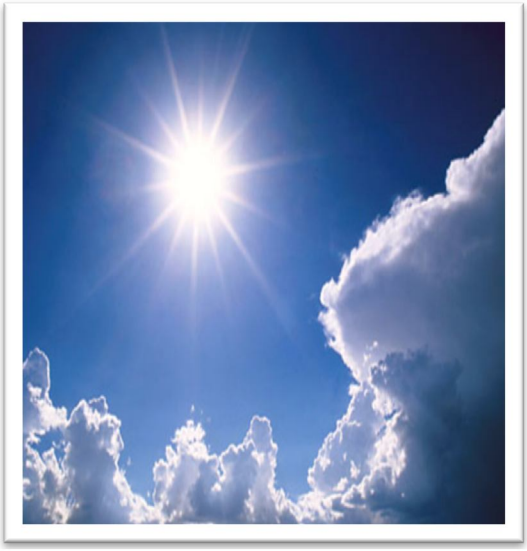


Plate 3.1, The sun.
Source: Boone, Microsoft Encarta (2011)



Plate3.2, The sun setting
Source; Encyclopaedia Britannica (2011)

Daylight consists of two words “day” and “light”. The word “day” according to Microsoft Encarta dictionary (2011), is a part of a twenty four hour period when it is light, between sunrise and sunset, and, the word ‘light’ is defined as the energy which produces a sense of brightness that makes seeing possible. Combining the two words, “daylight” is the condition of brightness created by the rays of the sun during the day. Therefore, “day lighting” according to Ander (2008) is the controlled admission of natural light into a space through openings to reduce or eliminate electric lighting. Daylighting aids to create a visually stimulated and productive environment for building occupants, while reducing as much as one-third of total building energy costs (Ander, 2008). Energy savings can be achieved either from the reduced use of artificial (electric) lighting or from passive solar heating or cooling. Artificial lighting energy use can be reduced by simply installing fewer electric lights because daylight is present, or by

dimming/switching electric lights automatically in response to the presence of daylight, a process known as daylight harvesting.

In the course of this research, number of terminologies will be used, therefore, the important terminologies are defined subsequently.

3.2.1 Definition of important terminologies in daylighting

i. **Illuminance**

This is the amount of light which is evaluated according to its capacity to produce visual stimulation, that reaches a unit surface area during a unit time. It is measured in Lux.

ii. **Illumination**

This is the provision of light to make something visible or bright.

iii. **Luminance**

This is the measure of the brightness of a surface, equal to the amount of luminous flux arriving at, passing through, or leaving a unit area of surface. It is measured in candelas per square area.

iv. **Glare**

This is difficulty seeing in the presence of very bright light.

v. **Reflectance**

The ratio of the energy of a wave reflected from a surface to the incident wave.

vi. **Translucent**

This is allowing light to pass through but only diffusely, such that the objects on the other side cannot be clearly distinguished.

3.3 HISTORY OF DAYLIGHTING IN BUILDINGS

From the earliest caves, daylight informed the lives of the inhabitants initially in the difference between night and day but as dwellings became more sophisticated by means of openings or windows letting in light, the history of architecture became synonymous with the history of the window and of day lighting from the initial crude openings, letting in light and air, heat and cold, the window was the vehicle for the introduction of daylight, and ultimately to the wondrous interiors of the mediaeval cathedral, the Baroque churches or the many private buildings of the eighteenth century (Philips, 2004).

Windows have developed over the centuries, but the purpose of letting in daylight has remained the primary role; window openings required a suitable infill to modify the external climate. At first various materials were used, such as thin slabs of marble, sheets of mica or oiled paper, but it was not until the development of glass for windows that substantial progress could really be made (Philips, 2004).

Philips, (2004) further reminded that glass had been discovered as early as 3000 BC in Egypt, and was used for decorative objects, but it is known that small panes of hand-blown glass set into bronze frames were used for the infill to window openings during the Roman period. These were little different to the leaded lights of the mediaeval period, being limited to the small pane sizes governed by the manufacturing process. It was left until the seventeenth century for large panes of glass to be developed in England and for larger windows to be made possible. The history of windows is really the history of architecture, from the crude openings in the sides of early domestic buildings open to the atmosphere, or openings in the roof construction, allowing the entry of rain collected in a central pool.

Windows have always led to innovation, and this can be seen in the stained glass windows of the great mediaeval cathedrals, telling the Christian story, where whole walls of glass were made possible by structures such as the flying buttress. Windows had to serve military needs in fortified buildings, leading to slit windows from which arrows could be fired; with splayed sides having the desirable effect of reducing the contrast between the brightness of the window and the interior wall surface, a device which has continuing validity (Jewell, 2002)

Whilst the vertical windows set into the outside walls of buildings were clearly of the first importance, and continue to be so today, it was the roof lights allowing daylight into the central parts of buildings that had an important influence on the plan form of the stately homes of the

seventeenth and eighteenth centuries. These took several forms, from domes such as that at Keddleston Hall (1759) where light enters from the top or Chiswick House (1725) where the dome is surrounded by windows in the sides, in both cases the method of daylighting allowed architects to have more flexibility to plan the central areas of their buildings. It is of interest that this method of introducing daylight to the centre of buildings has a resonance with the atria which we see in many buildings today.

Philips, (2004) further explained that the modern movement in England in the 1930s used the new methods of construction available, to allow an entirely new approach in residential buildings, with whole walls of glass and wrap-around windows at corners to express the freedom of the relationship between inside and outside, a freedom which was ultimately expressed in the walls of glass now possible in tall structures.

Daylighting remained the primary means of lighting to all types of building until the early twentieth century, when for various reasons, not least the greater efficiency in the development of electric sources, the primary role of daylighting was beginning to be questioned. This development led to windowless factories, and even windowless schools, the ultimate idiocy. It was even mooted that buildings could be heated by the means of lighting, leading to artificial lighting being used at all times of day, even when the heat generated had to be wasted, by dispersal. This was an 'engineering-led approach' and some architects tended to be carried along with it, although it must be said that the more thoughtful architects resisted.

This continued not until the energy crisis that it was realized, our reliance on fossil fuels had limitations, that people started to question this high energy approach, and began to look at ways to reduce the electricity load in buildings, and one of the more obvious ways was to return to an understanding of the natural resource of daylight (Philips, 2004).

3.4 CONCEPT OF DAY LIGHTING IN BUILDINGS

Philip, (2004) explained Passive architecture as, where the structure of the building is designed in such a manner as to reduce the need for mechanical controls of heat, light and sound to a minimum: the term 'Net Zero Energy Demand' or a situation where 'the energy consumed equals the energy harvested.'

Daylight and sunlight are at the heart of this new philosophy; they arrive every day in greater or lesser quantity, and provide power for lighting in two ways.

- First they enter the building through openings as 'light' to the interior spaces.
- Second they impact with the exterior building surfaces, and can be translated into energy by means of solar conversion (Philips, 2004).

According to Ander (2008), daylighting design process involves the integration of many disciplines including architectural, mechanical, electrical, and lighting. These disciplines need to be brought into the process early to ensure that daylighting concepts and ideas are carried throughout the project.

1. An awareness of basic visual acuity and performance issues is essential to an effective daylighting design which includes;
    - **Veiling Reflections**

      Veiling reflections are high brightness of light sources on surfaces that obscure details by reducing contrast. Ruck et al, (2000) also stated that it is visual discomfort or glare resulting from bright reflections off shiny surfaces. These veiling reflections reduce contrast and impair visibility. Daylighting systems can reduce or eliminate veiling reflections by controlling direct sun and luminance levels within the offending zone or the area viewed by the task surface.

- **Distribution** Introduce as much controlled daylight as deep as possible into a building interior. The human eye can adjust to high levels of luminance as long as it is evenly distributed. In general, light which reaches a task indirectly (such as having bounced from a white wall) will provide better lighting quality than light which arrives directly from a natural or artificial source.
- **Glare**

  The aim of an efficient daylighting design is not only to provide illuminance levels sufficient for good visual performance, but also to maintain a comfortable and pleasing atmosphere (Ander, 2008).
- **Variety**

  Some contrast in brightness levels may be desirable in a space for visual effectiveness. Dull uniformity in lighting can lead to tiredness and lack of attention neither of which is compatible with a productive environment

2. In order to have good daylighting requirement, attention should be paid to both qualitative and quantitative aspects of design. Make sure the combination of natural and artificial sources provides adequate light levels for the required task.

3. To be effective, daylighting must be integrated with electric lighting design. In particular, daylighting must be coupled with efficient electric lighting controls if net energy savings are to be realized (Ander, 2008).

- As part of a daylighting design, consider the use of continuously dimming fixtures controlled by luminous sensors.

3.5 DAYLIGHT DESIGN

Daylighting design refers to the consideration of key space design parameters that affect daylight performance, such as orientation and massing, size and placement of apertures, glazing and shading systems, and geometry and reflectance of interior surfaces.

Lloyd (1997) defines sustainability in architecture as 'development that meets the needs of the present and is at least as valuable to future generations as the value of the environmental exploitation that results to a sustainable building (in energy terms) is one that over its life breaks even or is in credit in respect of energy consumption.'

If daylight is to be at the heart of this equation, then the use of energy for artificial lighting in buildings must be reduced by the intelligent use of daylighting design; since it is now possible for the deficit in energy to be made up by means of solar conversion: the use of photovoltaic, powerful enough to generate sufficient energy to meet or exceed its lifetime consumption.

Lloyd, (1997) asserted that sustainable architecture is associated with minimizing all the different aspects of energy consumption associated with the production of a building from materials to construction methods and transportation, together with the continuing operation of the building throughout its life; but it is with the energy used for artificial lighting and the possible economies associated with sunlight and daylight that we are concerned with here the development of a strategy for design, a strategy which involves all the relevant criteria leading towards a holistic solution.

Lloyd, (1997) continued that if we ignore the demands made upon a 'passive' structure, by aspects of ventilation, air pollution, and the artificial lighting system, it is possible to outline a simple four-point strategy for daylighting design, bearing in mind that all the other factors need to be borne in mind to complete a holistic approach towards the building design.

i. A decision needs to be made on the sitting of the building, differing as to its location and site characteristics; in a green field or urban situation; taking into account the orientation, sun path and location of existing buildings or landscape.

ii. The building function may determine the room dimensions, heights, and subdivisions, bearing in mind the present and future needs of occupation. Room height is a key decision, having a bearing on daylight penetration and the desirable overall room depth as well as building costs.

iii. The window size and disposition. This is clearly the most complicated design decision, since it must incorporate all the human factors mentioned earlier, such as the provision of view, control of heat gain and loss and the elimination of glare, as well as the more obvious needs of functional vision.

iv. Finally control systems are a consideration, first, those controls which relate to the outside condition, the control of sunlight and the avoidance of glare; and second, those of the interior, the relationship with daylight and the artificial lighting system, to facilitate 'daylight linking'; this will be crucial to effect the possible savings in energy.

Whilst the four-fold decisions outlined are a necessary start, they must at each point be related to the other criteria for building design, not least of which will be the question of structural possibility, durability and its relationship to overall building costs, both initial and running costs, which relate to overall sustainability (Lloyd, 1997).

3.6 THE IMPORTANCE OF DAY LIGHTING IN BUILDINGS

According to Ruck et al, (2000) Daylight provides high illuminance and permits excellent color discrimination and colour rendering. These two properties mean that daylight provides the condition for good vision. However, daylight can also produce uncomfortable solar glare and very high luminance reflections on display screens, both of which interfere with good vision.

Thus, the effect of daylight on the performance of tasks depends on how the daylight is delivered. All of these factors need to be considered in daylighting design for buildings.

Daylight strategies and systems have not always lived up to their promise as energy efficiency strategies that enhance occupant comfort and performance. One reason is the lack of appropriate, low-cost, high-performance daylighting systems, simple tools to predict the performance of these advanced daylight strategies, and techniques to integrate daylight planning into the building design process.

Ruck et al, (2000) further enlightened the common barriers that have hindered the integration of daylight in buildings in the past are:

• Lack of knowledge regarding the performance of advanced daylighting systems and lighting control strategies,

• Lack of appropriate, user-friendly daylighting design tools, and

• Lack of evidence of the advantages of daylighting in buildings.

Daylighting of Buildings, were resolved by coordinated tasks that covered three broad areas:

1) Assessment of the performance of systems and lighting control strategies.

2) Development of integrated design tools.

3) Case studies to provide evidence of daylight performance in actual buildings.

There are many advantages of day lighting in buildings but for the purpose of this write up, some advantages will be highlighted.

i. Day lighting permits excellent colour discrimination and rendering which are essential in art galleries. (Ruck et al, 2000)

ii. Day lighting can reduce buildings electricity consumption, thus reducing emission of green house gases and fossil fuel depletion .(Ander,2008)

iii. Reduced operating cost- Artificial lighting accounts for (35-50) % of the total energy consumption in buildings. Thus the use of day light can reduce the amount of money spent on lighting.(Ander,2008)

iv. The human eye sees better in natural light and day light provides high illuminance that is adequate for seeing.

v. Day lighting when designed to introduce variety is attractive, interesting and can be used to guide movement through a building.

vi. The experience of the world beyond the building, by the view to the outside, whilst this is associated with the factor of orientation, it has the added aspect of content . . . which can be of open countryside, trees and landscape, but more often than not of other buildings and street patterns (Philips, 2004).

vii. Increased user productivity-Day light enlivens a space and increases user satisfaction and visual comfort. It also results in less optical strain and discomfort.(Ander,2008)

viii. Fewer electric fixtures are required to produce adequate illumination levels in building interiors.(Ander,2008)

ix. Less maintenance is required in predominantly day lit buildings than dominantly artificially lit buildings.

x. Day lighting significantly improves the quality of light in the indoor environment. The quality of light available for seeing is as important as the quantity of light available.

xi. The natural appearance of a space, where the overall experience, the objects and surfaces, are modeled in daylight together with the addition of sunlight at certain times of day (Philips, 2004).

The art and science of proper daylighting design is not so much how to provide enough daylight to an occupied space, but how to do so without any undesirable side effects. It involves more than just adding windows or skylights to a space. It is the careful balancing of heat gain and loss, glare control, and variations in daylight availability. Successful daylighting designs will

invariably pay close attention to the use of shading devices to reduce glare and excess contrast in the workspace. Additionally, window size and spacing, glass selection, the reflectance of interior finishes and the location of any interior partitions must all be evaluated (Ander, 2008).

Glare is a big problem associated with daylighting, it will be therefore discussed below.

3.7 GLARES AS A PROBLEM OF DAY LIGHTING

According to Schreuder, (2009) Glare is caused by a significant ratio of luminance between that which is being looked at and the glare source. Factors such as the angle between the task and the glare source and eye adaptation have significant impacts on the experience of glare and disability glare. Ander, (2008) further mentioned that the human eye can function quite well over a wide range of luminous environments, but does not function well if extreme levels of brightness are present in the same field of view. A factor which greatly determines glare is the position of the viewer in relation to the source of glare. Generally the nearer the source of glare is and the larger it is, the more severe the impact. Another factor that determines glare is the sky luminance

A daylighting design should be evaluated to determine whether there are strategies or features that enable occupants to control situations where the eye is forced to adapt to different brightness regions within the field of view Ruck et al, (2000). Glare can be generally divided into two types, disability glare and discomfort glare.

3.7.1 Disability glare

Disability glare is caused when intraocular light scatter occurs within the eye, the contrast in the retinal image is reduced (typically at low light levels), and vision is partly or totally impeded. With windows and day lighting systems, which are large-area light sources, disability glare can at times be significant. Experts agree that this apparent reduction in contrast is affected by the total intensity of the glare source not just by the brightness or area alone (Ruck et al, 2000)

3.7.2 Discomfort glare

Discomfort glare is a sensation of annoyance caused by high or non-uniform distributions of brightness in the field of view .The physiological mechanisms of discomfort glare are not well understood; an assessment of discomfort glare is based on size, luminance, and number of glare sources, source-task-eye geometry or glare source locations within the field of view and background luminance. (Ruck et al, 2000)

3.7.3 Analysis of daylight system for glare

i. **Luminance**

For tasks involving a computer screen with an average luminance of 85 cd/m2, the maximum luminance level of surfaces within the field of view is 300 cd/m2 for tasks within the immediate background and 850 cd/m2 for tasks within the general background.

ii. **Size**

The average luminance of any 0.6 by 0.6 m area within the field of view should be kept below 850 cd/m2.

iii. **Luminance Ratios**

The distribution of illuminance and luminance is a measure of how lighting varies from point to point across a plane or surface. For good visibility, some degree of uniformity across the task plane is desirable. Poor visibility and visual discomfort may result if the eye is forced to adapt too quickly to a wide range of light levels.

iv. **Geometry**

Glare sources must be kept out of the line of sight. For a horizontal view angle, sources within 50-90° above the horizontal can cause high-angle or overhead glare. (Ruck et al, 2000,)

v. **Type of finishes**

Matte finishes produce spread or diffuse reflection, thus the angle of incidence is not equal to the angle of reflection or such finishes reflect at all angles and exhibit little directional control thus eliminating glare.

3.8 DAY LIGHTING DESIGN

Advanced daylighting systems and control strategies are another step forward in providing daylight, user-friendly, energy-efficient building environments. These systems need to be integrated into a building's overall architectural strategy and incorporated into the design process from its earliest stages (Ruck et al, 2000).

3.8.1 Daylight Design stages

The different design stages and the daylight planning considerations for each stage are highlighted below.

i. **Conceptual Design**

As the building scheme is being created, day lighting design influences and/or is influenced by basic decisions about the building's shape, proportions, and apertures, as well as about the integration and the role of building systems.

ii. **Design Phase**

As the building design evolves, day lighting strategies must be developed for different parts of the building. The design of facades and interior finishing, and the selection and integration of systems and services (including artificial lighting), are all related to the building's day lighting plan.

iii. **Final/Construction Planning**

The selection of materials and products is affected by the building's day lighting strategy; final details of the day lighting scheme must be worked out when construction plans are created.

iv. **Commissioning and Post-Occupancy**

Once the building is constructed, lighting controls must be calibrated and ongoing operation and maintenance of the system begins. (Ruck et al, 2000)

3.9 DAYLIGHT DESIGN STRATEGIES

According to Ander, (2008) a number of design strategies should be understood and explored during the design process. These strategies are briefly described below.

- Increase perimeter daylight zones: extend the perimeter footprint to maximize the usable daylighting area.
- Allow daylight penetration high in a space. Windows located high in a wall or in roof monitors and clerestories will result in deeper light penetration and reduce the likelihood of excessive brightness.
- Reflect daylight within a space to increase room brightness. A light shelf, if properly designed, has the potential to increase room brightness and decrease window brightness.
- Slope ceilings to direct more light into a space. Sloping the ceiling away from the fenestration area will help increase the surface brightness of the ceiling further into a space.
- Avoid direct beam daylight on critical visual tasks. Poor visibility and discomfort will result if excessive brightness differences occur in the vicinity of critical visual tasks.
- Filter daylight. The harshness of direct light can be filtered with vegetation, curtains, louvers, or the like, and will help distribute light.
- Understand that different building orientations will benefit from different daylighting strategies; for example light shelves which are effective on south façades are often ineffective on the east or west elevations of buildings.

The daylight strategy is not just to supply a quantity of light enough for visual activities but a quality of light that is acceptable. This can be achieved by making day lighting design strategies and architectural design strategies one and the same at each stage of the design process.

3.9.1 Daylight strategies

This includes basic daylight components which makes influx of daylight into interior spaces possible.

1. SIDE LIGHTING

Side lighting aims to distribute daylight into the depth of a space to provide enough light for performing a task in the room while avoiding glare and allowing a view to the outside Ruck et al, (2000). Kroelinger, (2005) contributed that besides supplying light, side lighting can provide view, create orientation, allow connectivity to out-of doors, and allow ventilation during less harsh times of the year as seen in plate 3.3. Daylight openings and external controls should vary by compass direction since each façade of a building, based on orientation, receives differing amounts of daylight throughout the day and across seasons. Location of openings in walls can be low, middle, or high depending on desired distribution and structural and wall system restrictions.



Plate 3.3; usage of side lighting

Source; Kroelinger (2005)

Common side lighting strategies are:

- **Single side lighting** from one direction provides a strong directional quality of light with rapid deprecation of light quantity away from the window. Plate 3.4 shows such type of lighting strategy.



Plate 3.4; showing the usage of side lighting from top floor
Source; Kroelinger (2005)

- **Bilateral lighting** occurs when light enters rooms from two side directions, thus improving uniformity of distribution depending on width of room, height, and location of glass (Kroelinger, 2005). Bilateral side lighting can provide occupants with a view to the surrounding landscape. This strategy as seen in plate 3.5 allows effective solar shading by moveable systems on a sunny façade while the second facade, which is not hit by direct sunlight, distributes daylight to the space (Ruck et al, 2000).



Plate 3.5; Showing bilateral lighting system
Source; Kroelinger (2005)

- **Multilateral lighting** enters from several directions and can reduce contrast and glare, improve uniformity of light on horizontal and vertical surfaces

2. TOP LIGHTING

According to Kroelinger (2005), top lighting is penetration of daylight into a building from above the ceiling plane or is concentrated in the roof. Top lighting can provide greater freedom of source placement to achieve more uniform illumination, takes advantage of high wall surfaces and other architectural elements to distribute light where needed, and increases security and privacy. Top lighting includes roof monitors and skylights and saw tooth shown in plate 3.6 below.



Plate 3.6; Aalto's Academic Bookstore, Helsinki, Finland showing skylighting from top floor
Source; Kroelinger (2005)

- **Skylights**

This is a relatively horizontal glazed roof aperture for the admission of daylight.

(Rudolf, 2002). Skylights are placed horizontally in flat or sloped roofs can provide a uniform level of illumination throughout a space when skylights are spaced on a ratio of 1.5 times ceiling height. Skylights are generally effective for lighting horizontal tasks and function best for one-story buildings. The performance of skylights differs under clear versus overcast skies. Thermal gain is an issue in hotter climates. There are different types of skylight as seen in figure 3.1, figure 3.2 figure 3.3 and plate 3.7 which includes; Dome skylight, Hip ridge sky light, Ridge skylight, Pyramidal sky light, Circular sky light and Polygon sky light.

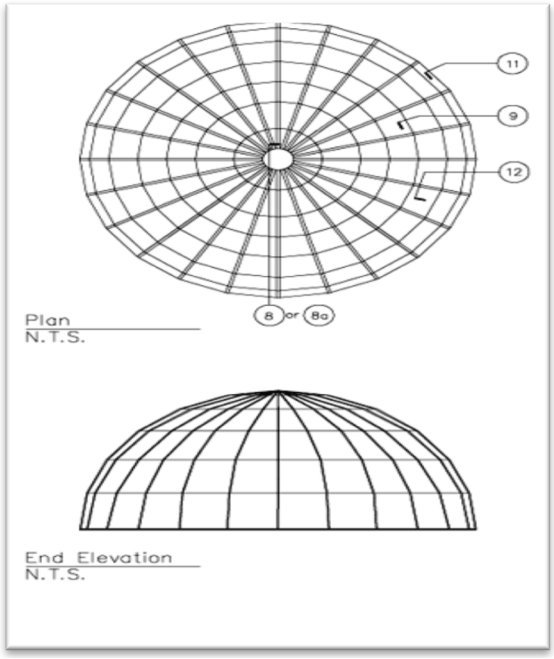


Fig 3.1; dome sky light

Source: www.googleimagesearch.com, (2011)

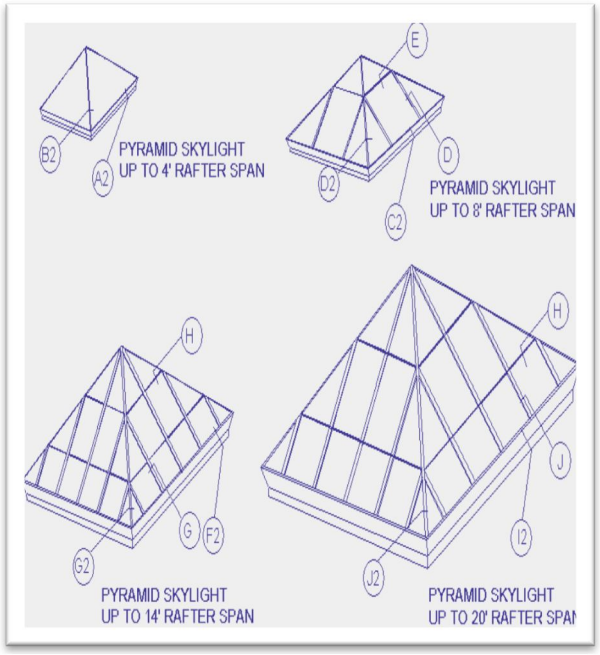


Fig 3.2; Types of pyramid sky lights.

Source: www.googleimagesearch.com, (2011)

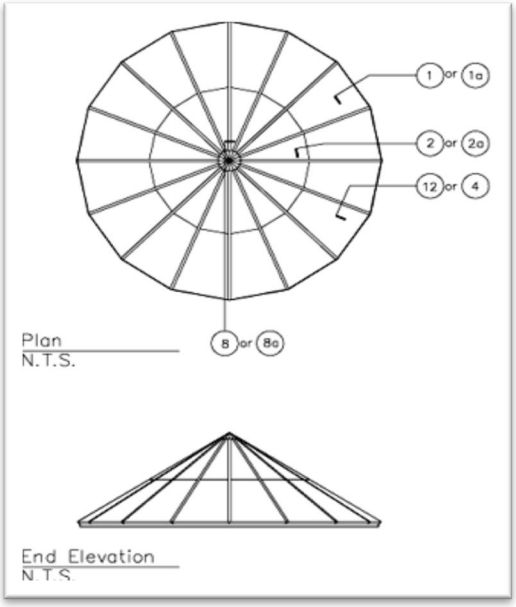


Fig 3.3; Schematic sketch of polygon sky light

Source: www.wascoskylights.com, (2011)

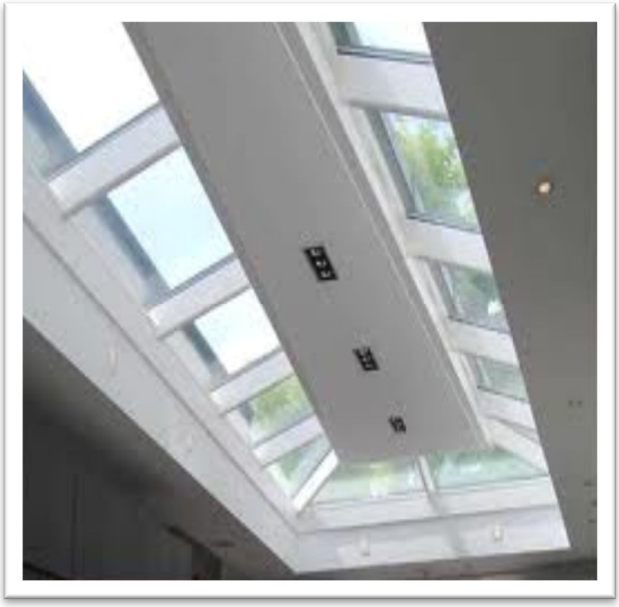


Plate 3.7: ridge sky light

Source: natural light.co.uk (2011)

- **Roof monitors**

  They are raised or elevated roof planes. The higher plane contains the monitor which illuminates task areas under each monitor bay. Glazing may be vertical or sloped. North facing monitors perform differently from south facing monitors. Monitors should be avoided on east and west orientations.

- **Sawtooths**

  Sawtooths are apertures with vertical or angled glazing installed in a slopped roof plane. Sawtooths are most effective when used in series of three and were historically used in industrial and manufacturing buildings as the primary light source. Plate 3.8 shows a saw tooth roof light with slope generally at a 45 degree angle.

- **Roof lighting**

  A roof light according to Microsoft Encarta (2009), is 'An opening in the roof or ceiling that is fitted with glass to let in day light'. Another definition of roof light is "A horizontal glazed roof aperture that is parallel or nearly parallel to the roof" (Ander, 2008). Plate 3.9 shows a ridge roof lighting system.



Plate 3.8; Schematic sketch of polygon sky light

Source: rooflight.co.uk (2011)



Plate 3.9: ridge sky light

Source: rooflight.co.uk (2011)

Types of roof lights includes: Shed roof light, monitor roof light, unequal vertical monitor roof light, saw- tooth roof light with vertical glazing, twin sloping monitor roof light, saw-tooth roof light with sloping glazing, vertical and sloping monitor roof light.

- **Courtyards**

Courtyards are outdoor areas open to the sky and are partially or totally enclosed by the building. In partly enclosed courtyards, the north orientation should be the open segment to reduce glare and to reduce the need for sun control. Façade and ground materials should reflect daylight and sunlight without increasing glare for building users (Kroelinger, 2005).

- **light wells**

Light wells are openings in the ceiling or floor of a room that allow daylight penetration to the floor, or floors, below. Light wells are generally utilitarian shafts for daylight and ventilation and are not occupied space. Performance of light wells depends on depth and the aspect ratio of the shaft. It is best to consider a light well as a source of supplementary light (Kroelinger, 2005).

- **Atrium**

The atrium is a core lighting technique used in many modern multi-storey buildings. The centre of the building is opened up with a glazed element at the top. The outside perimeter is lit with windows whilst the centre receives diffuse light from the atrium. The ratio of height to width of the atriumpp should not be greater than 2:1 in most circumstances. If this ratio cannot be achieved, then it is also possible to use reflectors or diffusers suspended within the atrium space to bounce light sideways and therefore deeper into adjacent internal spaces**,** (Marsh, 2006). Plate 3.10 shows such daylight being distributed from a central medium in Kimbell Art museum



Plate 3.10; Louis Kahn's kimbell art museum showing day lighting distribution from a central atrium.

Source: daylight museum guide, Hancock, (2009)

3.10 ADVANCED ARCHITECTURAL DAY LIGHTING SYSTEMS

The advance architectural daylight element includes;

1. **Light pipes**

Lightducts and lightpipes are among the more mechanically complex daylighting devices. Sunlight is collected by heliostats (mirrors controlled by a tracking device), concentrated by means of mirrors or lenses, and then directed to the core of the building through shafts or through acrylic rods or fibre-optic cables. Plate 3.11 and plate 3.12 shows the mechanism used in this system of daylighting. Because they depend on direct sunlight, and are relatively expensive to install, they will be cost-effective only in regions where blue skies and clean air can be guaranteed for much of the year. Energy-efficient back-up lamps may be fixed at the head of the shaft to substitute for sunlight during infrequent overcast conditions. More details and specifications of light pipes are illustrated in figure 3.4, figure 3.5 and figure 3.6 below



Plate 3.10; A light pipe

Source: www.googleimagesearch.com (2011)



Plate 3.12; A light pipe showing sun path

source; inhabit.com (2011)

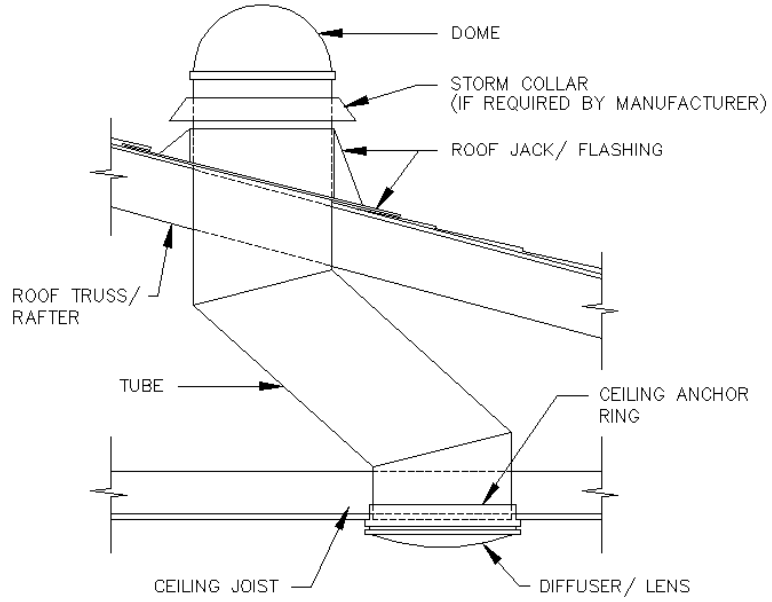


Fig 3.4; Section through a light pipe
Source: www.wascoskylights.com (2011)

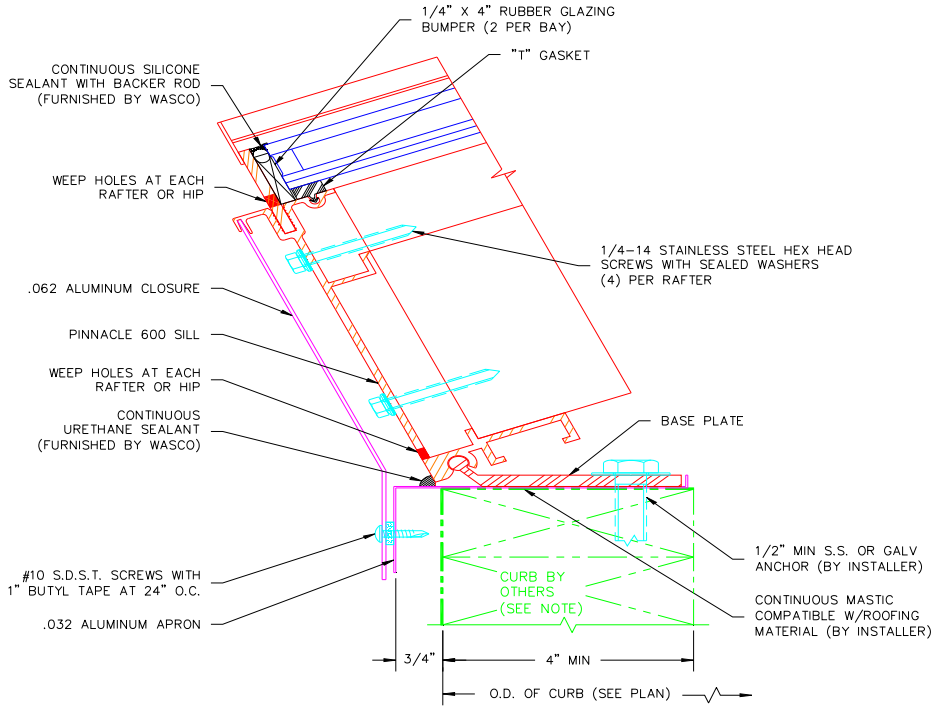


Fig 3.5 Sill detail for a light pipe Source: www.wascoskylights.com

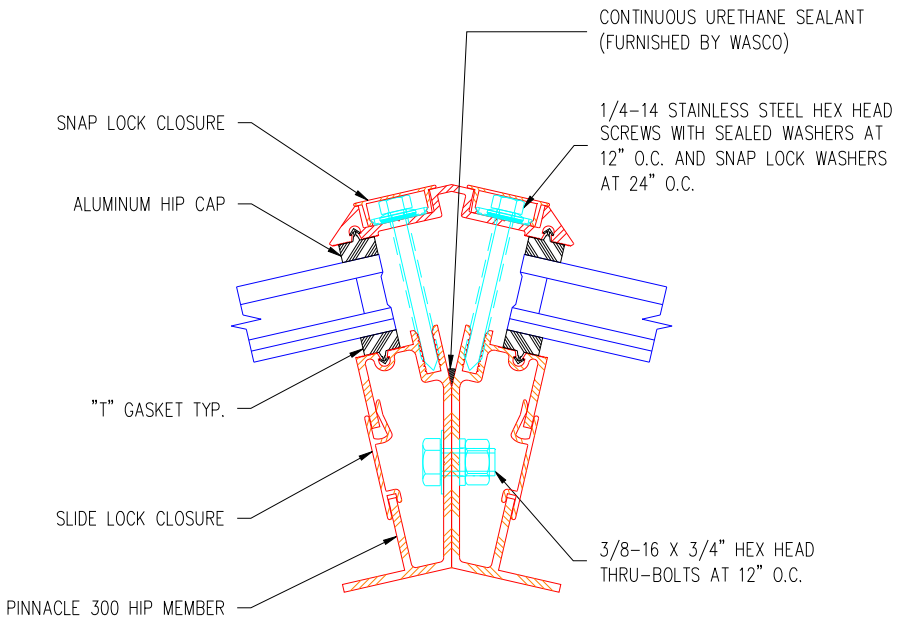


Fig 3.6 Ridge detail for light pipes

Source: www.wascoskylights.com

2. Light shelves

This is an exterior horizontal shelf positioned (usually above eye level) to reflect daylight onto the ceiling and to shield direct glare from the sky (Rudolf, 2002). The light shelf redirects incoming light onto the ceiling and simultaneously provides shading for the area of the room close to the window. The underside of the shelf can also redirect light from a high-reflectance exterior ground surface onto the floor inside the room. A light shelf is most efficient when it is external, causes minimal obstruction to the window area, has peculiar reflective surfaces, and is combined with a ceiling of high reflectance. Interior shelves have not been found to be as effective - they obstruct daylight entering the room while providing little compensating benefit.

3. Louvers and blinds

Louvers and blinds are classic day lighting systems that can be applied for solar shading, to protect against glare and to redirect daylight. Louvers and blinds are composed of multiple

horizontal, vertical, or sloping slats. There are various kinds of louver and blind systems, some of which make use of highly sophisticated shapes and surface finishes as seen in plate 3.13



Plate 3.13; Mechanism of louvers and blinds

Source; Hancock (2009)

4. Prismatic panels

Prismatic glass (or plastic) controls transmitted light by refraction and can be used to redirect or to exclude sunlight. The direction of incoming daylight is changed as it passes through an array of triangular wedges whose geometry can be designed for particular conditions and orientations. Prismatic glass is translucent rather than transparent, so cannot be used where a view outdoors is required. In several recent applications it has been used to reduce glare. Normally a prismatic refracting panel consists of two sheets with their prismatic faces facing each other to protect them from dust accumulation. Prismatic sheets can also be used within double-glazed units. While the sheets themselves are inexpensive to manufacture, the overall construction cost is higher than for conventional glazing. Prismatic assemblies, including

sophisticated systems incorporating silvered wedge-faces and several panel types, are increasingly available.

5. **Light guiding shade**

   A light-guiding shade is an external shading system that redirects sunlight and skylight onto the ceiling. A light-guiding shade consists of a diffusing glass aperture and two reflectors designed to direct the diffuse light from the aperture into a building at angles within a specified angular range. The light-guiding shade is fixed in the same way as an external shade over a window; it shades the window from direct sunlight as a normal shade does.

6. **Anidolic ceilings**

An anidolic ceiling consists of daylight-collecting optics coupled to a light duct in a suspended ceiling. The system is designed for side lighting of non-residential buildings. Anidolic ceiling systems use the optical properties of compound parabolic concentrators to collect diffuse daylight from the sky; the concentrator is coupled to a specula light duct above the ceiling plane, which transports the light to the back of a room. The primary objective is to provide adequate daylight to rooms under predominantly overcast sky conditions.

3.11 DAYLIGHT AVAILABILITY

For daylight to be used it has to be available and certain factors affect the availability of daylight. All day lighting strategies make use of the luminance distribution from the sun, sky, buildings, and ground. Daylight strategies depend on the availability of natural light, which is determined by;

i. The latitude of the building site. High latitudes have distinct summer and winter conditions, the seasonal variation of daylight levels are less apparent at low latitudes.

ii. Site conditions surrounding the building, such as the presence of obstructions. On construction sites, the surrounding buildings and serve as obstructions to the sky. Studying the obstructions at a construction site tells a designer about the daylight potential of the building's facades and allows him or her to shape the building and to allocate floor areas with respect to daylight availability. (Ruck et al, 2000, p.3)

Day lighting strategies are also affected by climate; thus, the identification of seasonal, prevailing climate conditions, particularly ambient temperatures and sunshine probability, is a basic step in daylight design. In the tropics, such as Abuja-Nigeria daylight levels are high throughout the year, thus the design emphasis is on preventing overheating by restricting the amount of daylight entering the building. The obstruction of large parts of the sky, especially of areas near the zenith, and the admission of daylight only from lower parts of the sky or of indirect light reflected from the ground are useful strategies that can be adopted.

3.12 TOP LIGHTING DESIGN CONSIDERATIONS

When selecting a top light design for a building, there are certain considerations which must be made in order to select the right roof light that is functional for that building. These considerations are;

i. **Size**

The rule of thumb is that a skylight will illuminate a room 20 times its size. Sky lights should not be as large as possible because, a large skylight will not only bring in too much light into a room it will also bring in too much heat and may make the room feel uncomfortably like a greenhouse. (Ander, 2008)

ii. **Placement**

The position of a sky light is important to ensure maximal day lighting and/or passive solar heating potential. Skylights on roofs that face north provide fairly constant but cool illumination. Those on east-facing roofs provide maximum light and solar heat gain in the morning. West-facing skylights provide afternoon sunlight and heat gain. South-facing skylights provide the greatest potential for desirable winter passive solar heat gain than any other location, but often allow unwanted heat gain in the summer. (Ander, 2008)

iii. **Reflected light**

Straight skylights provide more direct and focused heat. Wide and angled skylights are usually a better choice as they disburse the light and heat throughout the room. Walls around the light should be splayed to further reflect the light.

iv. **Energy efficiency**

Energy efficiency is an important characteristic of building materials in the present day. Thus sky lights with low-E coatings, a low U-factor and low Solar Heat Gain Coefficient glass should be used. Plastic glazing should be avoided. (Ander, 2008)

3.13 DAYLIGHT MODELING

Daylight Modeling allows architects and designers to see the impact of variations in their daylighting strategies long before the space is constructed.

1. Avoid daylighting disasters and disappointments such as glare.
2. Better understand capturing LEED® points through well-planned daylighting
3. Develop optional daylighting design alternatives
4. Improve the environments for all living things
5. Enhance the well-being, peace of mind and productivity of occupants

3.13.1 Day lighting analysis and design tools

1. Physical Modeling

According to Ander, (2005), the physics of illumination are such that light behaves exactly the same way in a scaled model as it does in a full-size room. Physical models can be built inexpensively and at various stages of the design process as seen in plate 3.14 and plate 3.15. A number of issues can be accomplished with physical models.

- Photographs of the model interior can be taken to record and study various design alternatives;

- The effect of different glass areas and locations can be studied;
- Using photometers, illumination levels resulting from different daylighting schemes can be compiled and used to project energy savings.



Plate3.14; physical 1/50th scale model
source; Philips (2004)



Plate3.15; physical 1/50th scale model
source; Philips (2004)

2. Computer and Calculation Tools Over the past 50 years many daylighting calculation tools have been developed. These include hand methods, nomographs, and computer models to simulate both daylighting design and its impact on the overall thermal performance of buildings.



Plate 3.16; Actual photograph

source; Shalaby (2008)



Plate3.17; computer simulalated image showing daylight

source; Shalaby (2008)

3.14 DAY LIGHT IN ART CENTER

In the push towards sustainability and green design, daylighting is becoming critical to energy efficient design. In most situations daylight can be easily incorporated into building designs; however art centre designs provide a special challenge. Unlike most building situations, where direct sunlight can occasionally grace a surface, museums require that the UV exposure from direct sunlight be completely controlled in order to protect the integrity of the art and artifacts on display.



Plate 3.18; Louis Kahn Kimbell museum showing the introduction of natural lighting in exhibition space
Source; Hancock, (2009)

"So this is a kind of invention that comes out of the desire to have natural light. Because it is the light the painter used to paint his painting. And artificial light is a static light . . . where natural light is a light of mood . . . the painting must reveal itself in different aspects if the moods of light are included in its viewing, in its seeing. I think that's the nature, really, of a place where you see paintings."

Louis Kahn, Light is the Theme.

The following guide compiled by Hancock et al, (2009) will highlight the specific issues associated with daylighting art centre and museums will provide some basic rules of lighting galleries.

- While the daylighting of museums poses a unique and complex design problem, it is a surmountable challenge. Many design teams have successfully incorporated daylight into galleries while simultaneously accommodating the particular needs of the artifacts on display. In

fact, daylight provides better color rendering than electric lights, meaning that artifacts can be observed more closely to their actual resemblance.

- Daylighting additionally provides energy savings for the art centre by minimizing the amount of electric lighting required during the day to illuminate the museum. Over a period of time, these savings can help pay back the potential additional cost of construction from daylighting shown in the various plates below.
- Finally, daylighting improves the quality of experience of the visitor by providing a connection to the outside and showing the passage of time as the light changes throughout the day (Hancock et al, 2009).

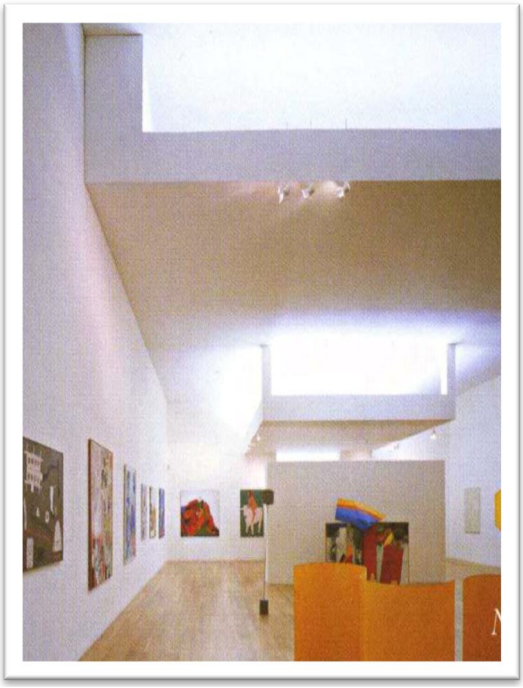


Plate 3.19; Museu de Serralves showing roof lighting
Source; daylighting museum guide (2009)

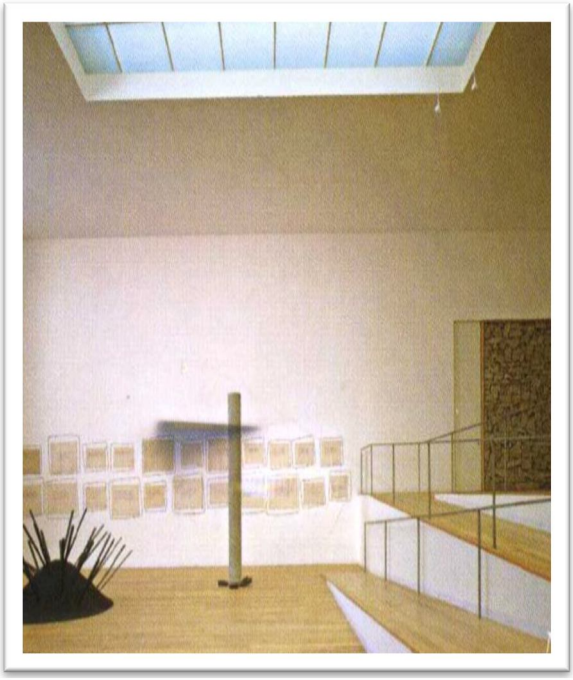


Plate 3.20; Museu de Serralves showing sky light
Source; daylighting museum guide (2009)



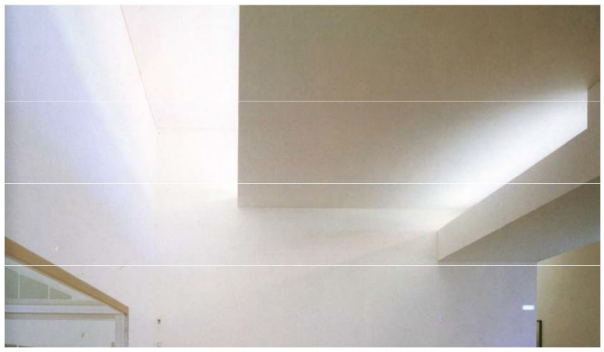


Plate 3.21; Museu de Serralve
Source; daylighting museum guide (2009)

3.14.1 Recommended practice

Hancock et al, (2009) recommends that effective daylighting can provide psychological and economic benefits. Psychologically, daylight is ever-changing and a constant source of visual interest. Although daylight is generally more expensive to control than electrical light, energy costs can be substantially reduced if daylight's use is well-planned. Poorly conceived use of daylight can result in high construction and energy costs, glare increased noise, condensation, leakage, and, most importantly, artifact degradation.

3.14.2 How to daylight an art centre

Hancock et al, (2009) stated that, generally, there are some basic principles to follow and aspects to consider when daylighting an art centre which are as follows:

1. Direct sunlight should be avoided completely in display spaces.
2. UV exposure should be limited using UV filters. These filters can be built into the glazing and should be specified appropriately.
3. A range of components should be considered:
    - Side lighting (view windows)
    - top lighting (clerestories and skylights),
    - shading systems (interior and exterior),
    - Sensors (light and occupancy)

A representation of the above mentioned is represented the various museums shown in the plates below.



Plate 3.22; Museu de Serralve showing side lighting
Source; daylighting museum guide (2009)

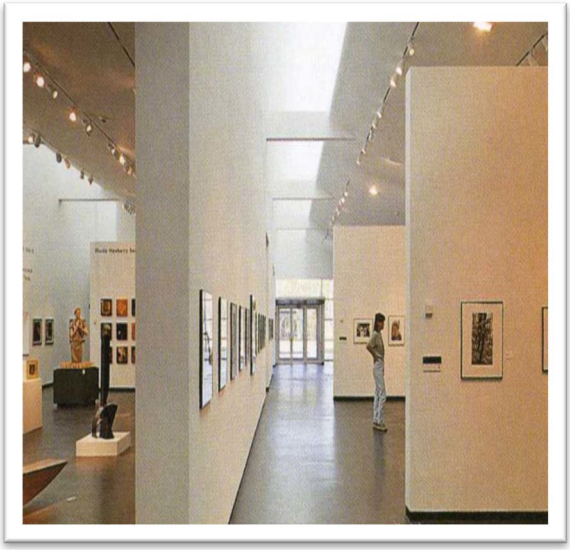


Plate 3.23; Gulf coast museum of art
Source; daylighting museum guide (2009)



Plate 3.24; Gulf coast museum of art
Source; daylighting museum guide (2009)



Plate 3.25; Audrey Jones Beck building
Source; daylighting museum guide (2009)



Plate 3.26; Audrey Jones Beck building
Source; daylighting museum guide (2009)

3.14.3 Generic sections for daylighting a gallery

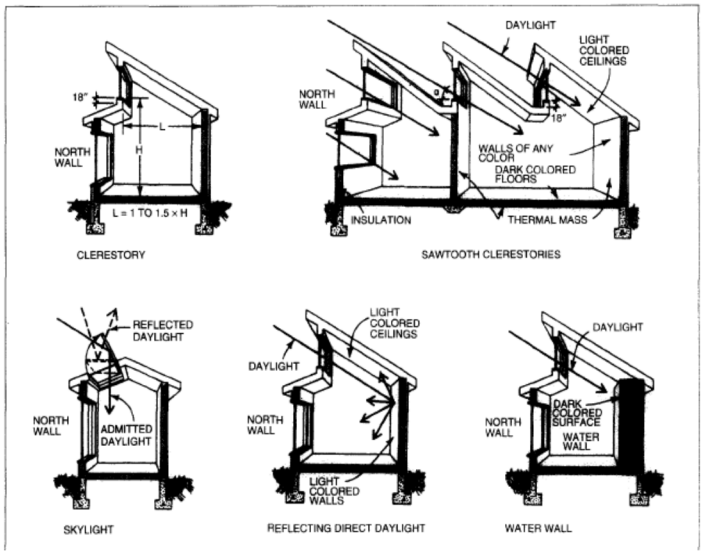


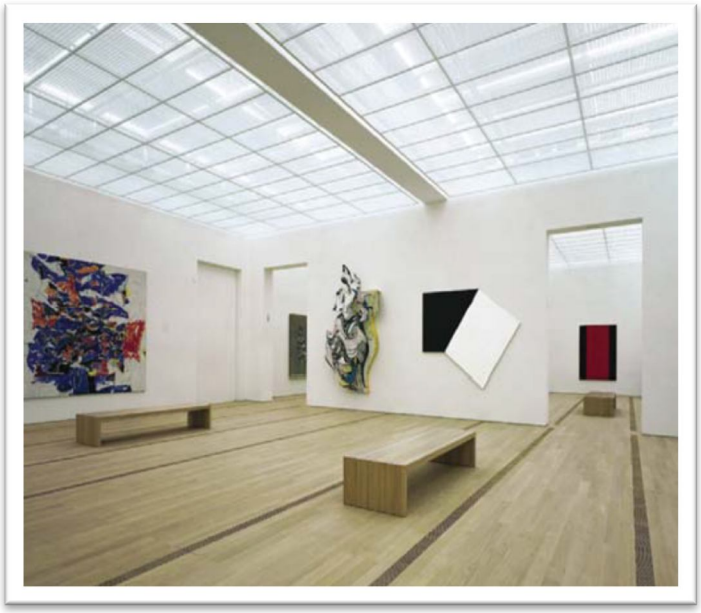
Fig 3.7; multiple architectural alternatives for admitting daylight
Source; museum daylight guide (2009)

3.14.4 Lighting Art and Artifacts

Hohmann et al, (2009) Beyond lighting general circulation and gallery spaces, the art and artifacts of galleries also require certain amounts and types of light. The following points will be required in lighting exhibits appropriately:

- When appropriately lighting an exhibit, it is important to consider not just the quantity but also the quality of the light used. In regards to color, it is important to light objects so that they bear "original appearance." Daylight assists with this because of its full color spectrum. Artificial lighting must be designed in such a way so as to incorporate this full spectrum, but this is much harder to do.
- Avoid lighting scenarios in the ultraviolet or infrared spectrum. All ultraviolet radiation can be filtered by selecting glazing with the appropriate specifications.
- The artefact should be visible when on display. There is no point causing a little damage (with insufficient light) for no purpose (the artifact cannot be seen).
- The institution (art centre) must decide how much light damage in how much time is acceptable, that is, what lifetime is desirable.
- The institution must acknowledge the sensitivity of each artifact, or group of artifacts, as accurately as possible.

1.5.3



1.5.4 Plate 3.27; Beyela foundation museum
Source; daylighting museum guide (2009)

3.15 CONCLUSION

Day lighting in buildings requires the co-ordinate effort of not just the architect but every professional in the building team. The choice of day lighting elements to be used is affected by a number of factors which include; climatic conditions of the site, type and function of building to be erected, desired aesthetics and the budget for the project. The type, size, location of day lighting element to be used must be considered right from the conceptual stages of the design, thus informing the orientation, shape or building form in conjunction with the function of the building. The negative aspects of day lighting such as glare should be considered in the building design and adequate measures taken to prevent its occurrence. Measures which can be taken to combat glare include multidirectional lighting, the use of shading devices, and the use of tinted of translucent glazing materials.

2 CHAPTER FOUR

2.1 CASE STUDIES

4.1 INTRODUCTION

Case studies are a means of getting practical information about similar buildings that have been designed and learning from the mistakes others have made as well as their successes.

4.2 CASE STUDY SELECTION CRITERIA

The criteria for selecting the case studies were;

i. The presence of day lighting architectural elements in the building.
ii. Building should be located in a climatic region similar to the climate of the proposed site for the research.
iii. A show case of indigenous art centre design.
iv. A show case of international art centre design
v. Scope of facilities provided;
vi. Architectural identity
vii. Innovation

4.3 METHODOLOGY

The methodology of carrying out the case studies was twofold. The first was by physically visiting the case study sites and practically accessing the architectural design parameters that are important in art centre design. The second was by assessing the means in which daylight is admitted in the buildings and the method used.

The case studies were assessed using both depended and independent variables. The variables considered for assessing the buildings selected are listed below.

i. Major Facilities

ii. Dominant building materials

iii. Use of artificial light

iv. Daylight element used

v. Building's architectural features and characteristics

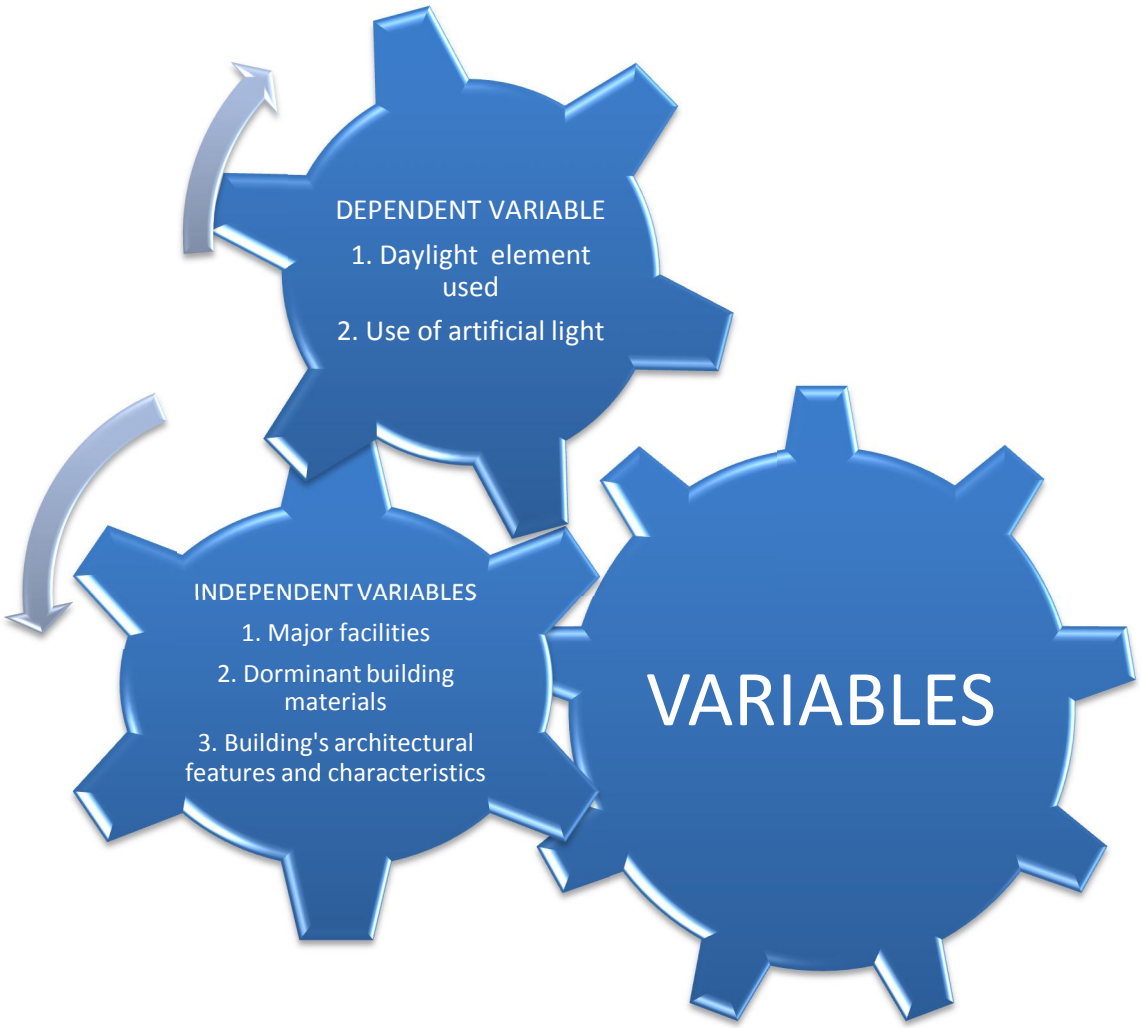


Fig 4.1; variables used for the case studies
Source; Researcher (2011

4.4 CASE STUDY ONE: CYPRIAN EKWENSI ART AND CULTURAL CENTRE



Plate 4.1; Cyprian Ekwensi Art and cultural centre
Source; Researcher (2011)

BUILDING INFORMATION
Architect: unknown
Client:
INTRODUCTION

This is a contemporary art and cultural centre located in the Federal Capital Territory, Abuja. It is a multidisciplinary centre for Nigerian contemporary art and culture which provides avenue for appreciation of visual and performance art. The gallery of the art centre is sound proof which provides the patrons less distractions.

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Studios -Museum -Exhibition space -Store -Performance space -Galleries -Shops -Workshop areas -Offices -Library -Multi- purpose theatre	- Concrete -Aluminum - Burnt Red brick	Electric light provides about 70% of light used in the gallery.	-Windows High level windows 3600mm×1200mm were placed in the gallery providing necessary brightness for seeing.	-Shape and form of the building The building is a two storey structure with unorganised placement of spaces. Though there is a distinctive representation of Nigerian traditional architecture by the use of round-shaped brick huts. -Building exterior The building exterior is painted white, with the columns and balcony painted in different patterns of contemporary art. -Landscaping The art centre also has an interesting landscaping of vast lawn area with artistic pieces of sculpture works. The workshops were located behind the building complex in round huts.

Table 4.1: Case study of Cyprian Ekwensi Centre for Art and Culture, Abuja
Source: researcher (2011)



Plate 4.2: A view in the art gallery
Source; Researcher (2011)



Plate 4.3: A view of the exhibition hall
Source; Researcher (2011)



Plate 4.4; View of the pottery workshop
Source; Researcher (2011)

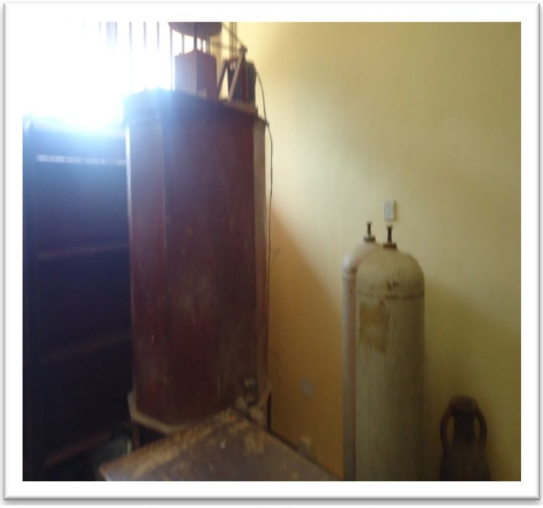


Plate 4.5; sculpture workshop equipments
Source; Researcher (2011)



Plate 4.6; A view of the parking lot
Source; Researcher (2011)



Plate 4.7; Showing graphics design workshop
Source; Researcher (2011)



Plate 4.8; The workshop buildings built of brick
Source; Researcher (2011)



Plate 4.9; Sculpture kiln
Source; Researcher (2011)



Plate 4.10; Painting studio
Source; Researcher (2011)



Plate 4.11; Showing textile workshop area
Source; Researcher (2011)



Plate 4.12; Storage for performance art
Source; Researcher (2011)

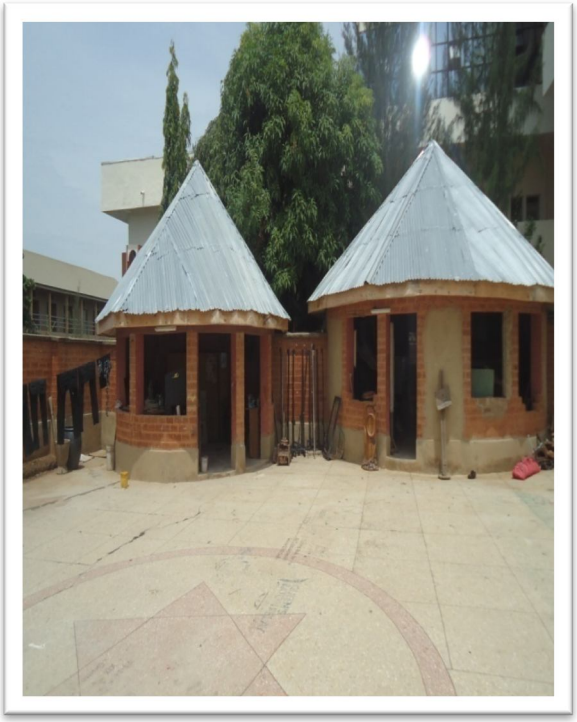


Plate 4.13; painting workshop
Source; Researcher (2011)

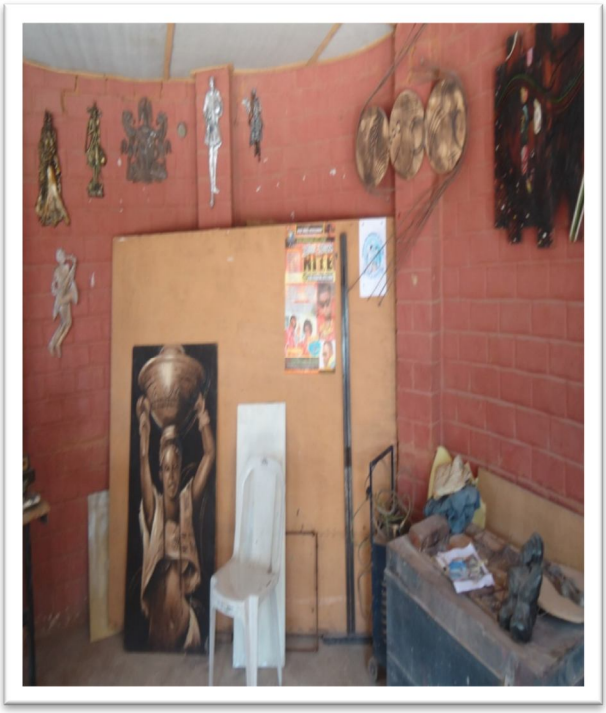


Plate 4.14; Store for art works
Source; Researcher (2011)



Plate 4.15; A view of the library
Source; Researcher (2011)



Plate 4.16; View of the entrance to the art centre
Source; Researcher (2011)



Plate 4.17; Retail shops
Source; Researcher (2011)

4.5 CASE STUDY TWO: NIKE ART CENTRE, ABUJA



Plate 4.18; Nike art centre, Abuja
Source; Researcher (2011)

BUILDING INFORMATION
Architect: unknown
Client: Nike Davies Okundaye

INTRODUCTION

The Nike art centre is a multidisciplinary centre for cultural art located at kilometer 75 Abuja international airport road, Piwoyi Village of the Federal Capital Territory, Abuja. This institution has other branches in Lagos, Oshogbo and Ogidi. The institution offers an artist residence program majoring in the field of sculpturing, fine arts, textile (fabric design), carving, painting, performance art and folk art.

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Performance space -Galleries -Workshop (textile, painting, sculpture, carving, quilt, pottery and embroidery) -Offices -Residential space	- Concrete -Aluminum	The building uses artificial light together with daylight	-Windows 1200mm×1200mm windows were placed in the gallery providing necessary brightness for seeing.	-Shape and form of the building Form follows the use of basic shapes in composition. Curvilinear and rectilinear forms are employed to grace the overall form. -Building exterior The building exterior surface is designed with artistic heliographic of Nigerian contemporary art. The building is the first exhibit of the art centre because of its decorative and artistic characteristics. -Landscaping The art centre has an interesting landscaping of vast lawn area with artistic pieces of sculpture works, carvings, pottery and showcase of Yoruba traditional shrine.

Table 4.2: Case study of the Nike Art Centre, Abuja
Source: researcher (2011)



Plate 4.19; Nike art centre, Abuja
Source; Researcher (2011)



Plate 4.20; showing the compound
Source; Researcher (2011)



Plate 4.21; Nike art centre showing artistic representations on the building structure
Source; Researcher (2011)



Plate 4.22; Nike art centre's gallery
Source; Researcher (2011)



Plate 4.23; Showing gallery
Source; Researcher (2011)



Plate 4.24; Showing textile workshop
Source; Researcher (2011)

4.6 CASE STUDY THREE: KIMBELL ART MUSEUM, TEXAS



Plate 4.25: The Kimbell Art Museum
Source; wikipaedia (2011)

BUILDING INFORMATION

Architect: Louis I. Kahn

Location: Texas, USA

Structural engineer: August Komendant

Climate: Temperate

Context: Urban

Style: Modern

Size: 120, 000 square foot (11, 000 m²)

Date: 1972

Landscaping: George Patton

INTRODUCTION

The Kimbell Art Museum is situated in the Cultural District of Fort Worth, Texas, USA. The building consists of a series of parallel, cycloidal concrete shells in the form of barrel vaults with a counterpoint of three interior courts. The Architect deliberately played down external impact.

The museum is a series of modular units ranged side by side, horizontal and spreading which begin with the concept of the of space as an increment of function. The unit space is also an increment of light.

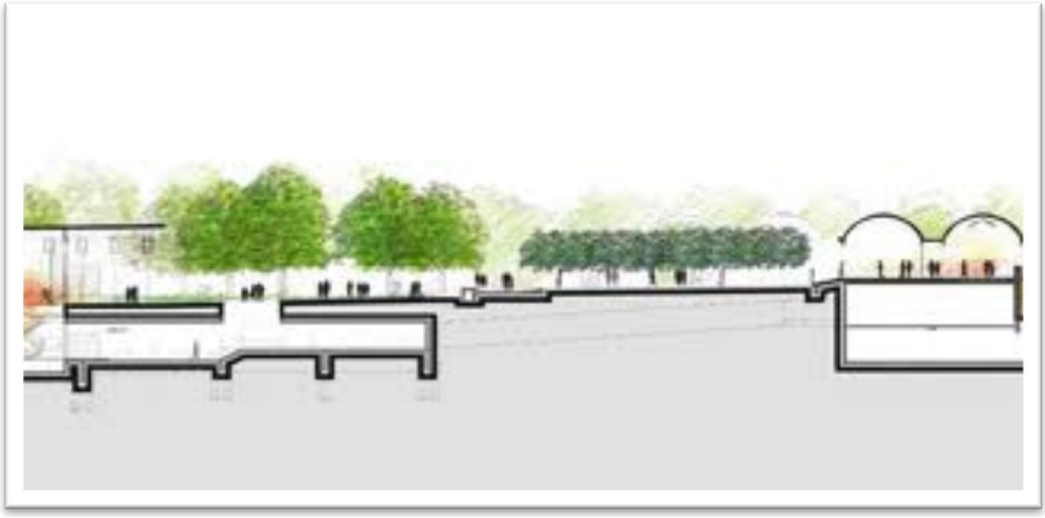


Plate 4.26: A sectional view of The Kimbell Art Museum
Source; Google search (2011)



Plate 4.27: Interior of the Kimbell Art Museum showing side and top lighting
Source; Google search (2011)

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Galleries -Auditorium -Library -Light court -Bookstore -Garden entry -Portico -Offices	- Concrete -Glass	Obscure	-Toplighting The top lighting consists of post-tensioned vault roughly one hundred feet long with a twenty-two foot span. The vaults act as curved beams with the light slot minimally bridged every ten feet to unite the two halves as a structural entity. -Side lighting The interior of the museum is also characterized by side lighting within the gallery space. These enhanced the galleries by bathing them in a silver glow but kept the light from directly touching the works of art.	-Shape and form of the building The Kimbell art museum appears as a brick block among other brick boxes, centrally located on its campus but without conspicuous axis, and without conspicuous entrance. -At the Kimbell, natural light enters the space through a 2½-foot slit at the apex of Kahn's distinctive vaulted ceilings. The light strikes a suspended convex, perforated-aluminum -The design of the building uses a developed system that allowed natural light into the galleries but diffused it with a series of innovative reflectors.

Table 4.3: Case study of the Kimbell Art Museum, Texas
Source: researcher (2011)

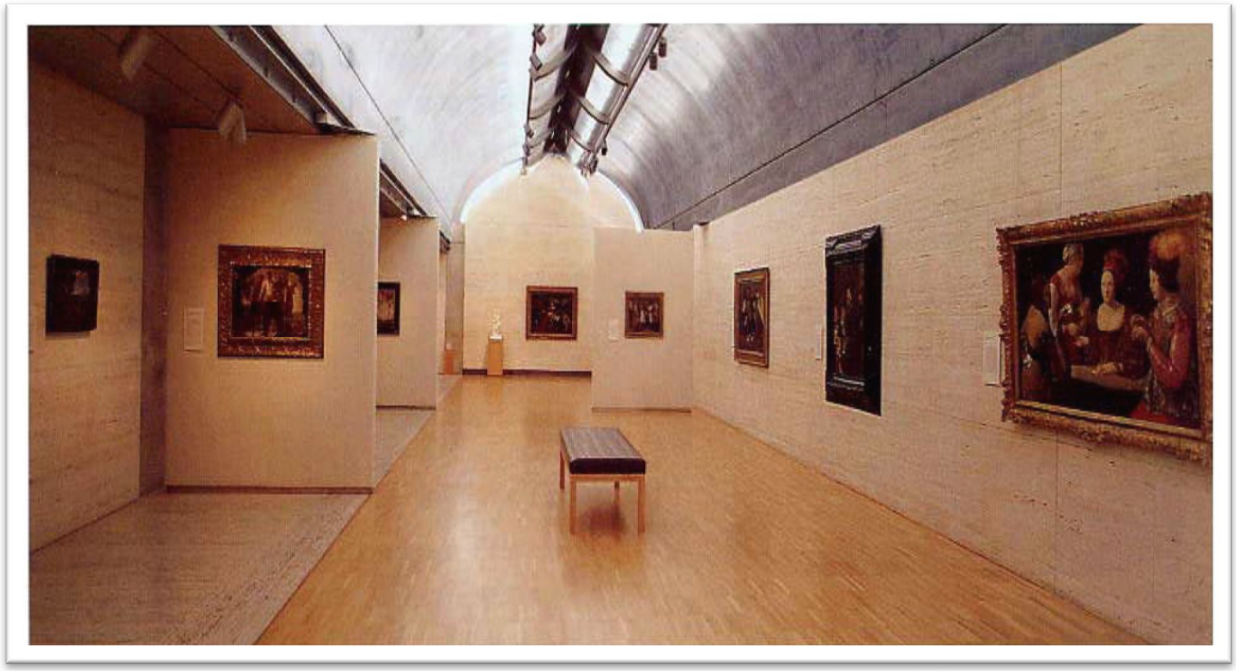


Plate 4.28: View of southeast gallery of the Kimbell art museum
Source; Ross (2009)



Plate 4.29: View of light diffuser of The Kimbell Art Museum
Source; Ross (2009)

3 4.7 CASE STUDY FOUR: HIGH MUSEUM OF ART, ATLANTA

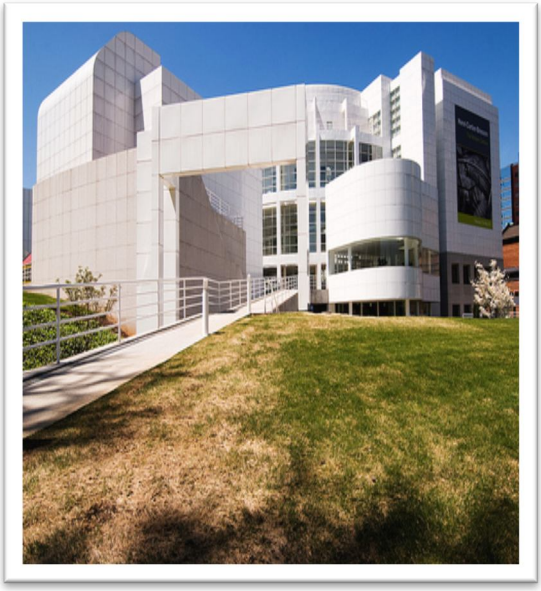


Plate 4.30; High museum of art, Atlanta
Source; Hancock et al (2009)

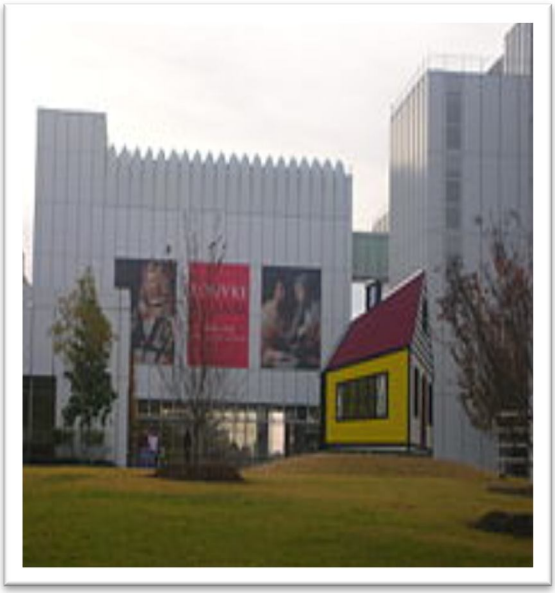


Plate 4.31; High museum of art, Atlanta
Source; Hancock et al (2009)

BUILDING INFORMATION

Architect: Richard Meier

Architect: Renzo Piano

Size: 312,000 sq. ft

Date: 1983 and 2005

INTRODUCTION

The museum, which was originally founded in 1905, and in 1983, it became a home to large collections of art ranging from a wide variety of eras. The contemporary look was brought on by architect Richard Meier. Then in 2005, an expansion was designed and built by Renzo Piano. Like most of his buildings, it is white, clad in this case in porcelain-enameled steel panels. Like the Atheneum, it uses an exterior ramp (with a square archway) to focus the eye and an interior ramp for circulation. It is a symbol of the museum's role as a place of aesthetic illumination and enlightened cultural values.

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Museum -Performance space -Bookstore -Museum shops -Boardroom -Office facilities --Galleries (temporary exhibition) -Film centre -Library and media library -Cafe -Auditorium	- Concrete -Steel -Glass The structure consists of steel columns and frame and concrete slabs.	Electric light was provided to be used especially at night and on cloudy days.	-Rooftop sails Rooftop sails funnel soft northern light into the galleries through cone shaped openings. -Mini skylight Each mini skylight twists slightly to focus the light and diffuse it through the top floor galleries housing the museum's permanent collection. -Use of atrium	-A majority of the interior was designed to allow a lot of natural light. Another thing is that the natural light was still subdued so as to not overpower the art. - it uses an exterior ramp -It is white, clad in this case in porcelain-enameled steel panels.

Table 4.4: Case study of high museum of art, Atlanta
Source: researcher (2011)

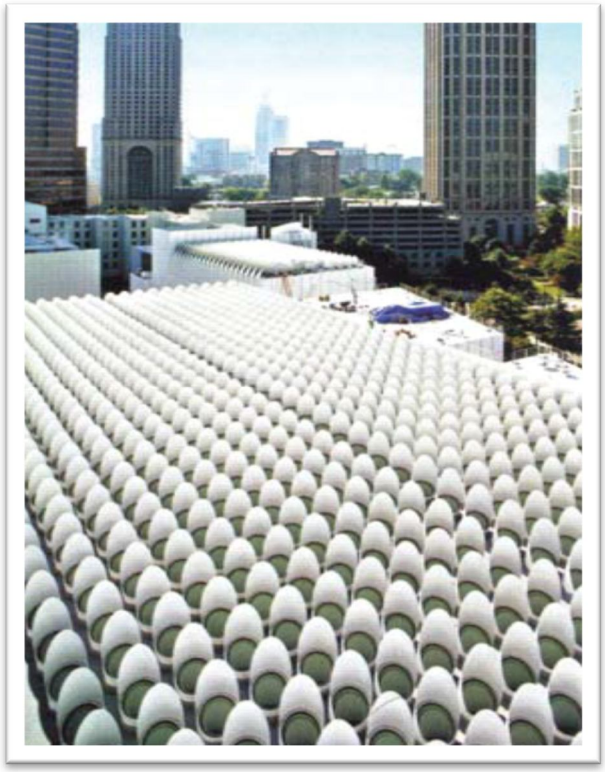


Plate 4.32; High museum of art showing rooftop sails
Source; Hancock et al (2009)



Plate 4.33; High museum of art showing openings on roof
Source; Hancock et al (2009)

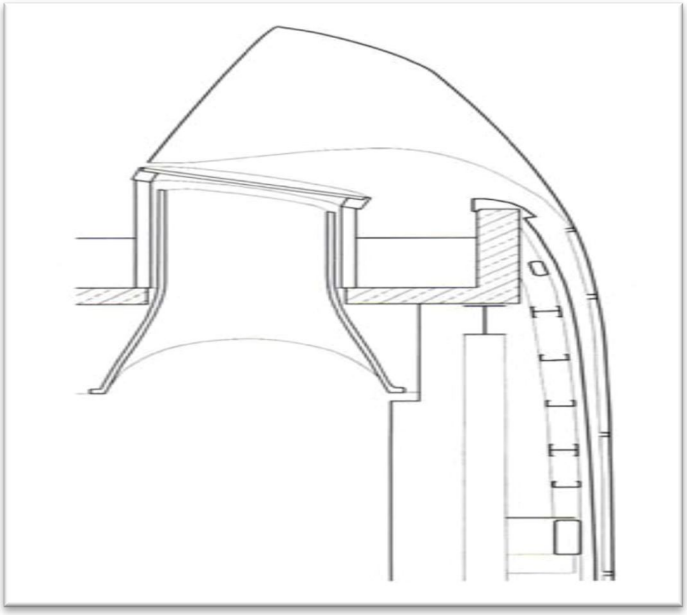


Plate 4.34; High museum of art, Atlanta
Source; Hancock et al (2009)

4 4.8 CASE STUDY FIVE: NORTHCAROLINA MUSEUM OF ART



Plate 4.35; North Carolina museum

Source; Scott Frances (2011)

BUILDING INFORMATION
Architect: Thomas Phifer
Location: Raleigh, North Carolina**,** USA
Partner in Charge: Thomas Phifer **AIA**
Project Partner: Greg Reaves AIA LEED AP
Project Architect: Gabriel Smith AIA LEED AP
Local Architects: Pierce Brinkley Cease + Lee, Raleigh, NC
Structural Engineer: Skidmore, Owings & Merrill LLP, Chicago, IL
Mechanical Engineer: AltieriSeborWieber LLC, Norwalk, CT
Landscape Architect: Lappas + Havener, PA, Durham, N.C.
Lighting Design: Fisher Marantz Stone, New York, NY
General Contractor: Barnhill, Raleigh NC
Project Area: 136,000 sqf
Project Year: 2010
INTRODUCTION
The North Carolina Museum of Art (NCMA) has a presence of daylight in its lush surrounding fields which is a presence unusual in institutional galleries for art.



Plate 4.36; showing glazed entrance

Source; Scott Frances (2011)

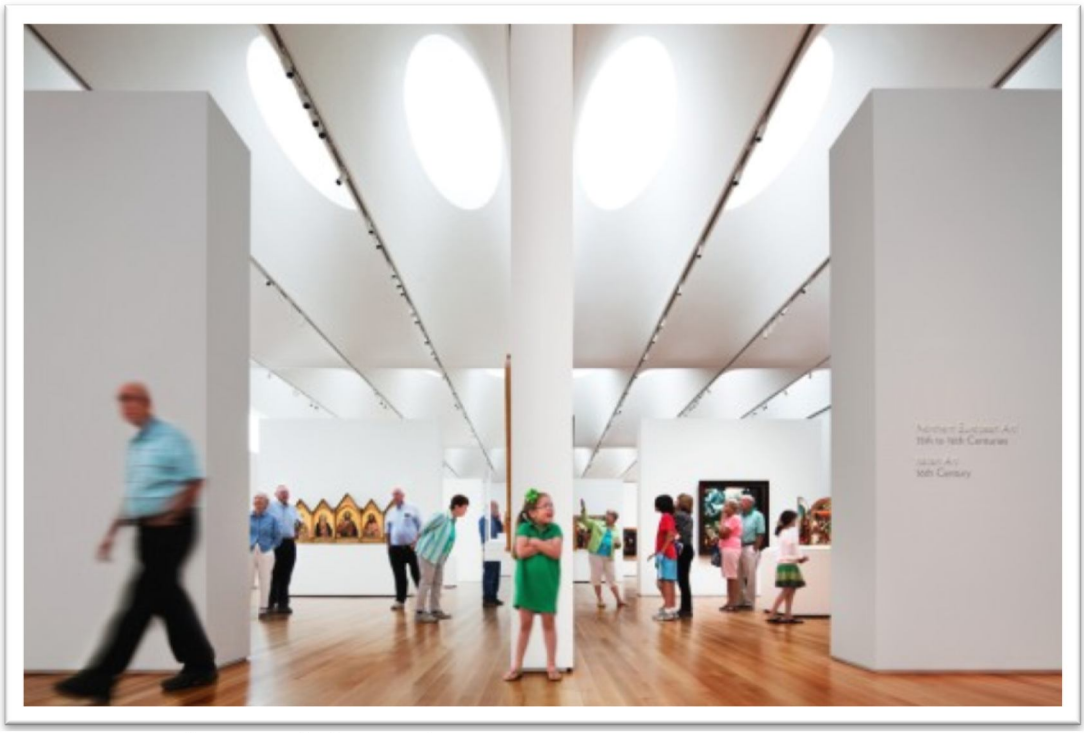


Plate 4.37; showing the elliptical oculi

Source; Scott Frances (2011)

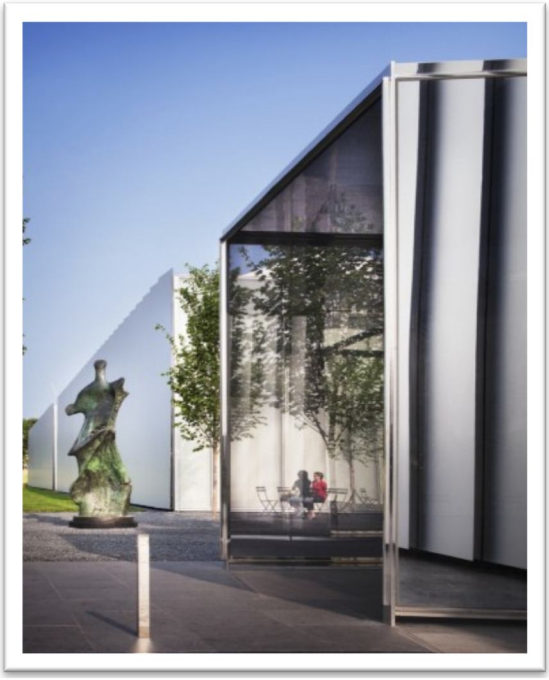


Plate 4.38; courtyard

Source; Scott Frances (2011)

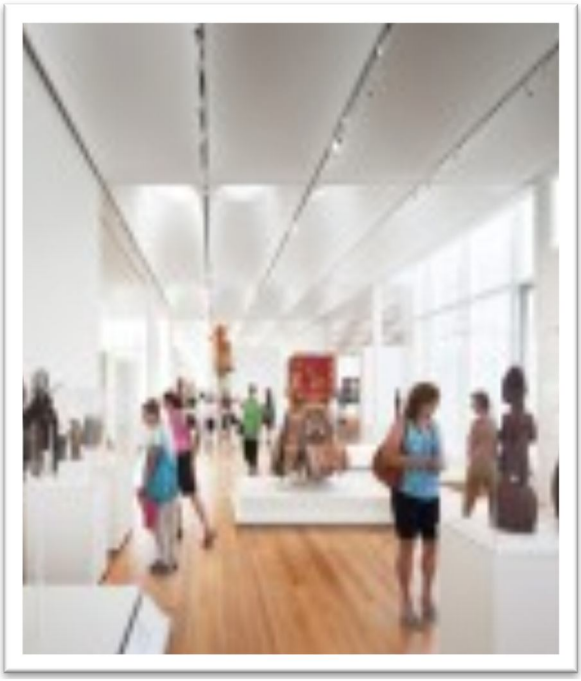


Plate 4.39; showing influx of daylight

Source; Scott Frances (2011)

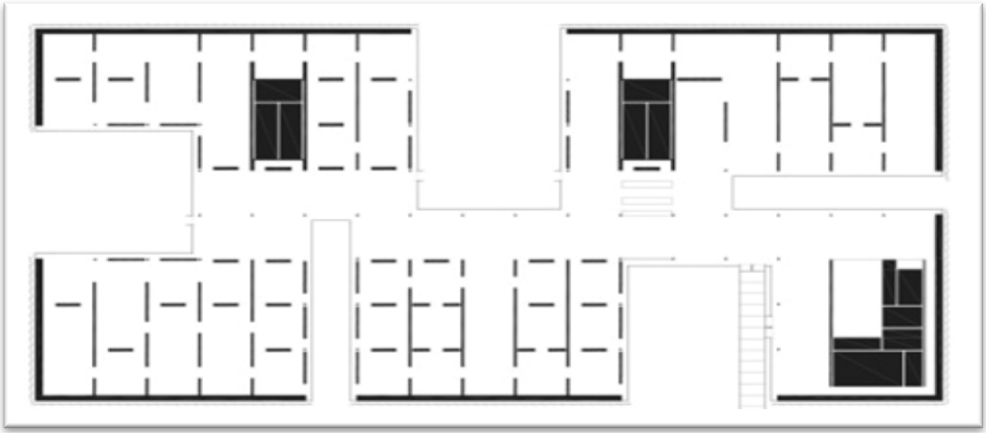


Plate 4.40; ground floor plan of North Carolina museum
Source; Scott Frances (2011)

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Galleries -Kiosk -Hall -Exhibition space	- Concrete frame & precast concrete barrel vault roof -Use of pale matte iodized aluminium panels -Mirror polished stainless steel -Extensive use of photovoltaic glass	White electric bulbs were placed on the ceiling to enhance the effect of daylight and also used at night	-Glazed wall The entrance facade to the museum comprises completely of a glass wall from ceiling level to ground level. The glass was used that it creates union between the interior and exterior which evokes visual refreshments to occupants. -Elliptical oculi This elliptical oculi used in long parallel vaults bathe the museum interior in even, full-spectrum daylight, modulated by layers that filter out damaging rays.	-The building has succession of wall planes; many free standing without reaching the ceiling, delineate separate galleries. -Instead of fully enclosed rooms, each gallery has at least one open corner inviting fluid movement -Pure white walls were used to enhance reflection of daylight.

Table 4.5; Case study of North Carolina museum

Source; researcher (2011)

5 4.9 CASE STUDY SIX: **CONTEMPORARY ART MUSEUM, ST. LOUIS**



Plate 4.41; contemporary art museum, St Louis

Source; Helene Binet (2011)

BUILDING INFORMATION
Architects: Allied Works Architecture
Client: Contemporary Art Museum St. Louis
Location: St. Louis, Missouri, USA
Project Team: Brad Cloepfil, Kyle Lommen, Chelsea Grassinger, John Weil, Chris Bixby, Nathan Roelofs, Jake Freauff, Andrew Kudless, Keith Alnwick
Collaborator: Bob Kirk, Architectural Concrete Associates
Landscape Architecture: Reed|Hilderbrand

INTRODUCTION
The Contemporary Art Museum St. Louis is located in a neighborhood of empty lots, burned out churches and lone townhouses that mark a lost twentieth-century urban ideal.
The new architecture for the Contemporary Art Museum St. Louis creates a "site" for art and the potential work of artists, work that can take any form or medium.

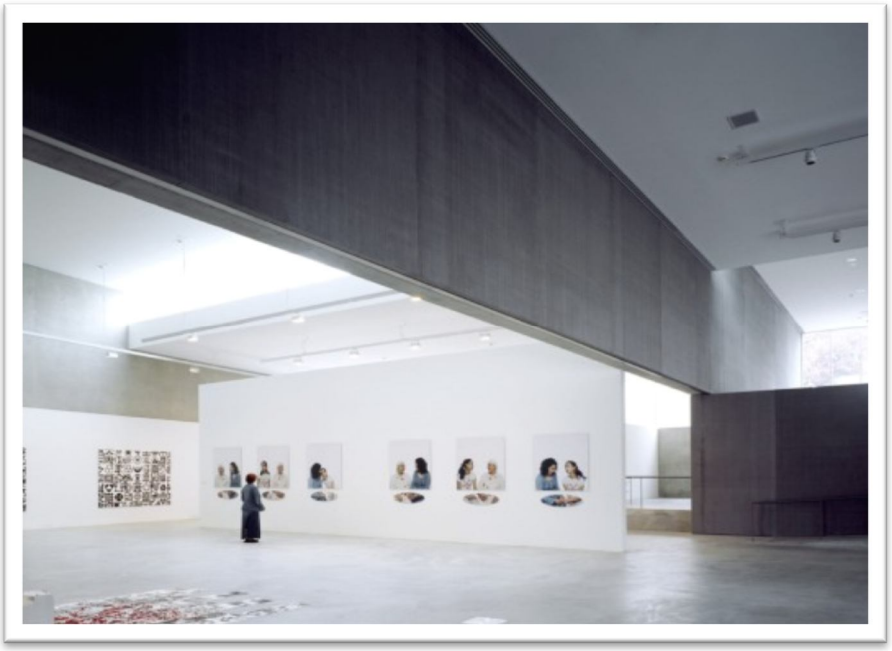


Plate 4.42; contemporary art museum, showing the use of light shelves

Source; Helene Binet (2011)

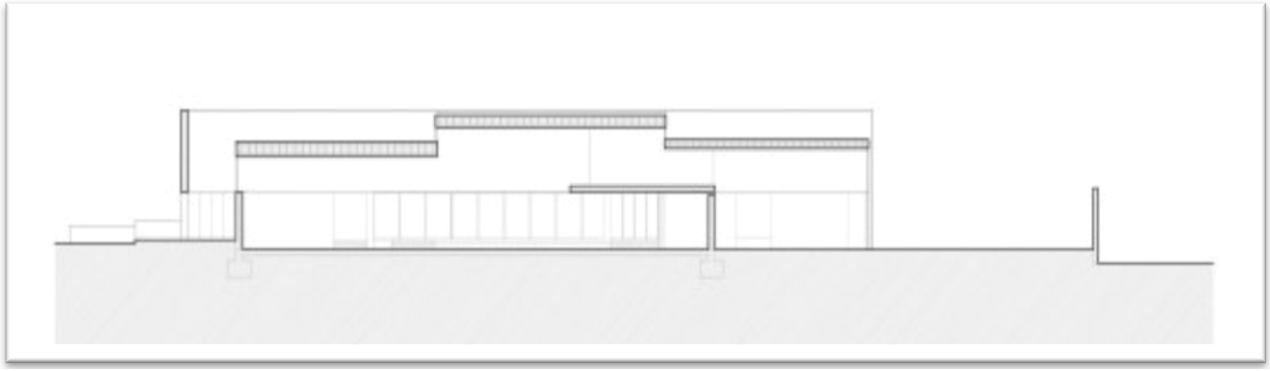


Plate 4.43; A sectional view of the contemporary art museum, St Louis

Source; Helene Binet (2011)

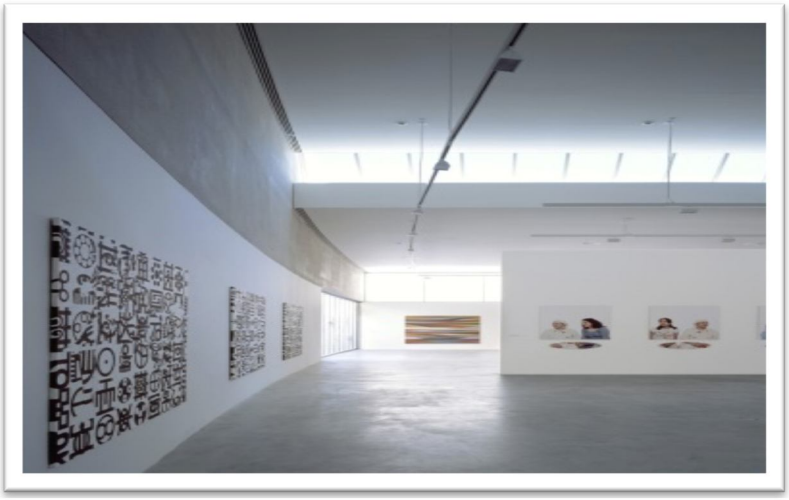


Plate 4.44; contemporary art museum, showing extensive use of daylight

Source; Helene Binet (2011)

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Galleries -Administrative offices -Exhibition halls -Educational facilities -Observatory	- Concrete -Precast concrete -Glass	White electric bulbs were used at night.	-Glazed wall Glass was used at different parts of the building which allow viewing of interior from outside. -windows The building has several low and high level windows which allow daylight extensively in this museum. -light shelves The light shelves used in the museum are made of concrete beams which run through the wall of the building. They are placed so that the sunlight drawn in by the windows is reflected and lights a room from top to bottom.	- The museum building is formed by two opposing walls of concrete, which intertwine and are cantilever. - The serpentine walls of the building touch the sidewalk and fold inwards, inviting the public to enter and providing views completely through the building from the street - The ceilings of the building float between lower and upper boundaries at varying heights, modulating the proportion and light of the galleries. - Pure white walls were used to enhance reflection of daylight

Table 4.6: Case study of contemporary art museum, St Louis
Source: Researcher (2011)

6 4.10 CASE STUDY SEVEN: **MAXXI - NATIONAL CENTRE OF CONTEMPORARY ARTS ROME, ITALY**



Plate 4.45; MAXXI - national centre of contemporary arts Rome, Italy

Source; Iwan Baan (2011)

BUILDING INFORMATION

Architect: Zaha Hadid with Patrick Schumacher

Client: Italian ministry of culture, Rome, Italy

Project architect: Gianluca Racana [Zaha Hadid]

Consultants: structure Anthony hunt associates [London, U.K]

Mechanical and Electrical: max Fordham and partners [London, U.K]

Lighting Design: equation lighting [London, U.K]

Acoustic: Paul gilleron acoustic [London, U.K]

Size/area : 30,000 m2

Project Years: 1999-2009

INTRODUCTION

The complex houses two institutions: MAXXI Art and MAXXI Architecture, aiming to promote art and architecture through collection, conservation, study and exhibition of contemporary works. In the MAXXI, the idea of a "closed" building gives way to a broader dimension, creating both indoor and outdoor spaces that become part of the surrounding city. Although the planning of the building was clear and organized, the main goal of the museum design was flexibility of use. It encompasses continuity of spaces which resulted to creation of a suitable place for any kind of moving and temporary exhibition, without redundant wall divisions or interruptions.

The concept for the project is based on the idea of 'irrigating' the large urban field with linear display surfaces, weaving a dense texture of interior and exterior spaces.

Two principle architectural elements characterize the project: the concrete walls that define the exhibition galleries and determine the interweaving of volumes; and the transparent roof that modulates natural light.



Plate 4.46; An aerial view of the MAXXI - national centre of contemporary arts Rome, Italy

Source; Iwan Baan (2011)

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Architecture centre -Auditorium -Galleries (permanent and temporary) -Commercial galleries -Conference centre -Reception services -Exhibition spaces (temporary exhibition) -Library and media library -Bookshop -Cafeteria -Laboratories -Performance space -Space for commercial activities -Space for leisure activities and studies	- Concrete -Steel -Glass	Electric light was provided to be used at night and some used during the day in areas where daylight was not introduced	-Glazed window Glazed glass was used for the windows and as wall from ground to ceiling of the ground level entrance facade. -Atrium Entering the atrium, the main elements of the project were clear which include concrete curved walls, suspended black staircases, and open ceiling catching natural light. - Skylight The roof is composed of integrated frames and louvers with devices for filtering sunlight, artificial light and environmental control.	-The attention of the natural lighting, by the thin concrete beams on the ceiling, the systems were covered and filtered together with glass. The same beams kept a bottom rail from which art pieces would be suspended. -The beams, the staircases in the building and the linear lighting system lead through the interior walkway, which terminate in a large space on third level. -There are also mobile panels in the exhibition spaces which offer curatorial flexibility.

Table 4.8; Case study of the MAXXI - national centre of contemporary arts Rome

Source; researcher (2011)

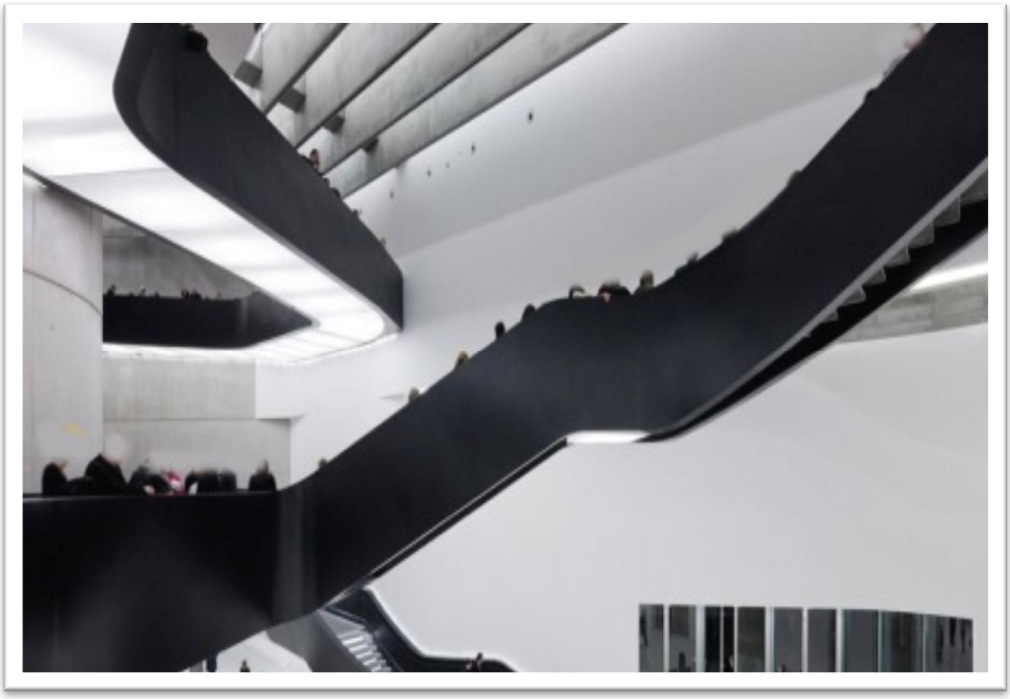


Plate 4.47; MAXXI - national centre of contemporary arts showing admission of daylight through the roof
Source; Iwan Baan (2011)

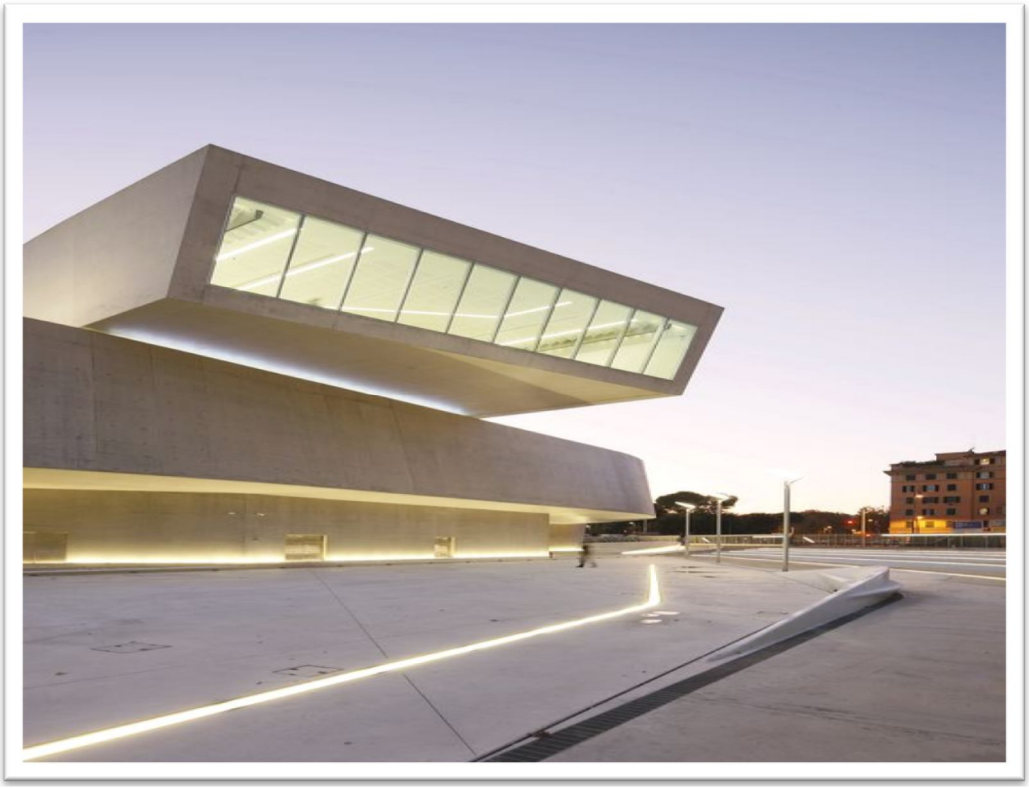


Plate 4.48; The MAXXI showing a side of the building and admission of daylight
Source; Iwan Baan (2011)

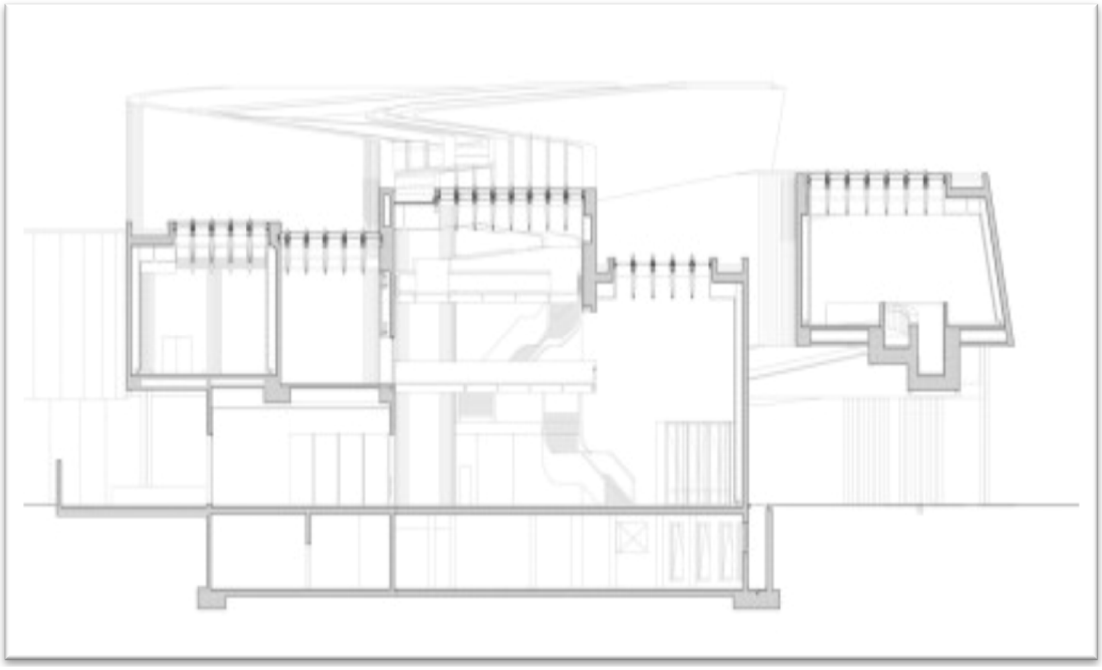


Plate 4.49; A section of the MAXXI centre of art
Source; Iwan Baan (2011)

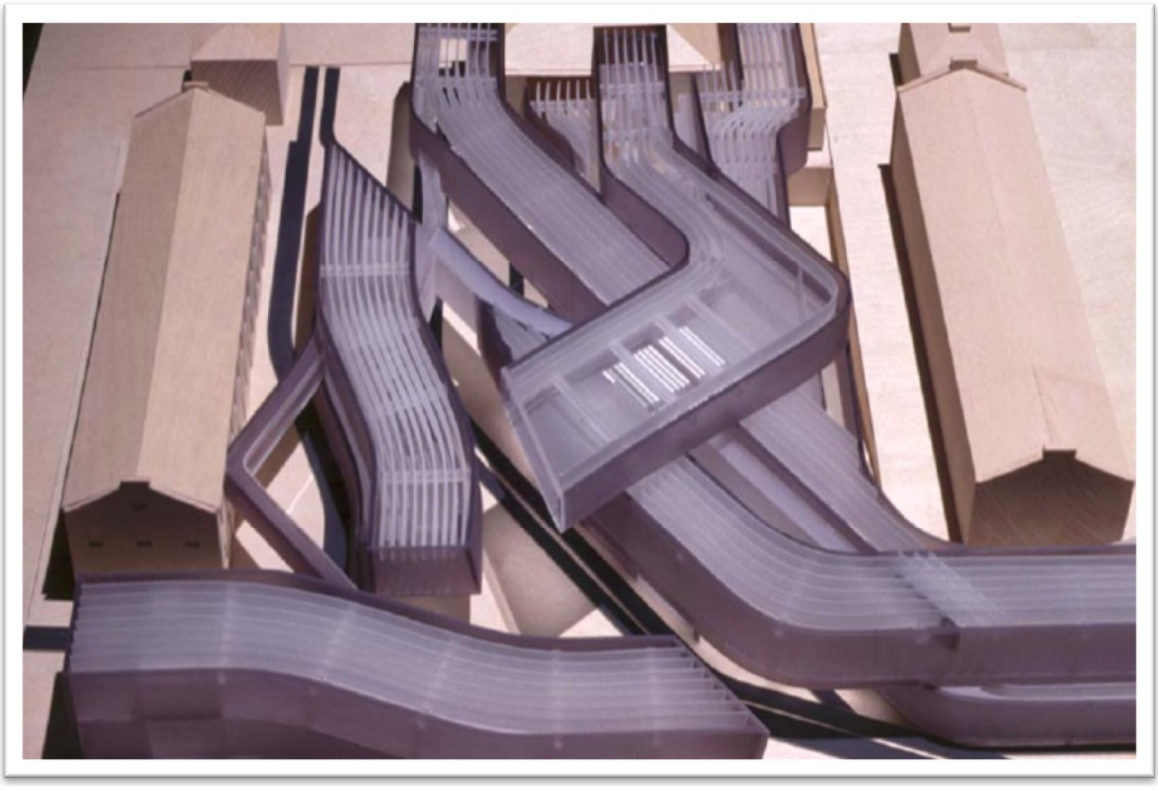


Plate 4.50; an aerial view of MAXXI

Source; Iwan Baan (2011)



Plate 4.51; MAXXI - national centre of contemporary arts Rome, Italy
Source; Iwan Baan (2011)

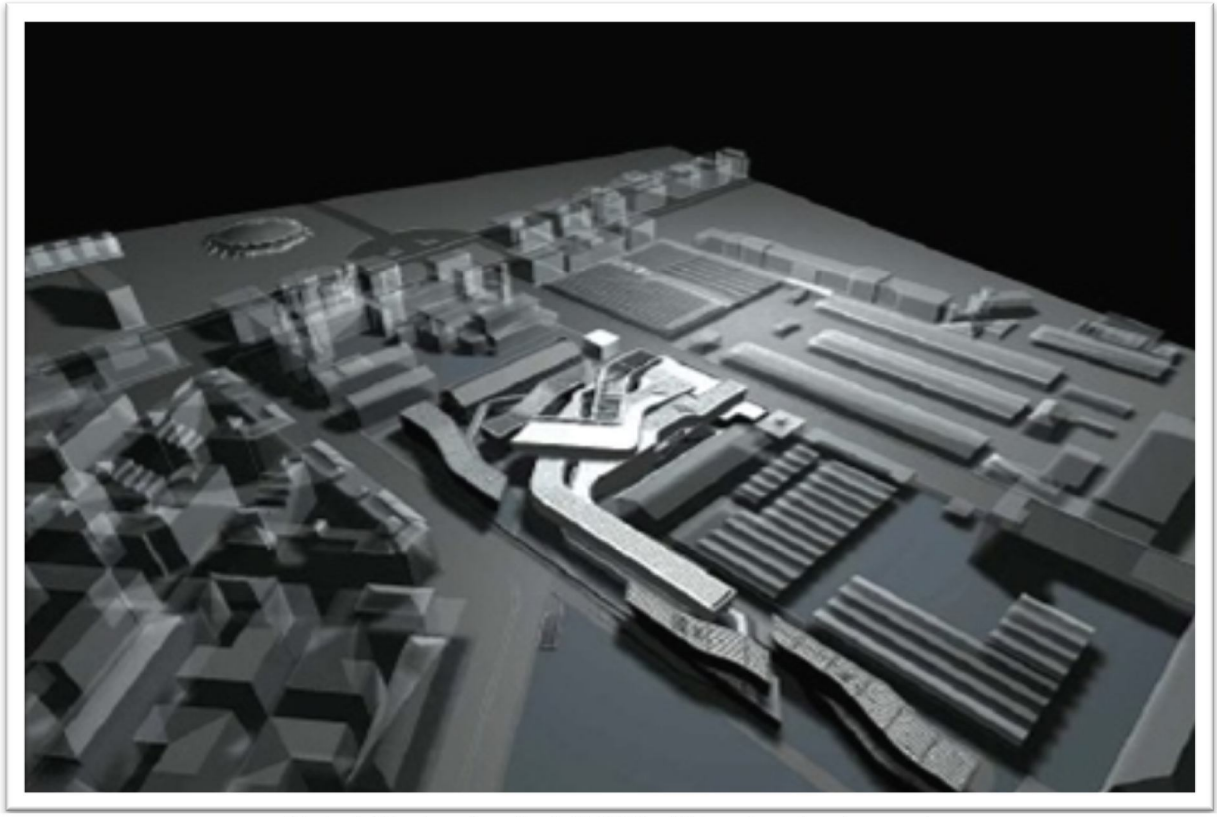


Plate 4.52; showing the MAXXI within urban development

Source; Iwan Baan (2011)

4.11 CASE STUDY EIGHT: ROSENTHAL CENTRE FOR CONTEMPORARY ART, CINCINNATI

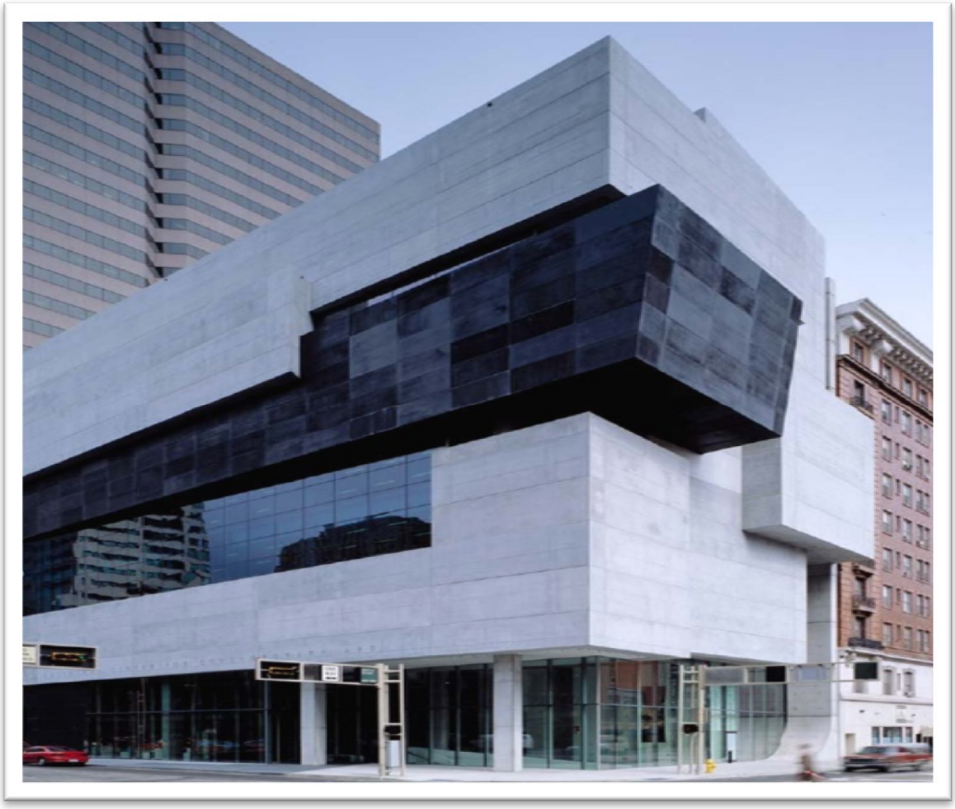


Plate 4.53; Rosenthal center for contemporary art, Cincinnati
Source; Helene Binet (2011)

BUILDING INFORMATION
Architectural design: Zaha Hadid Architects
Local Firm: KZF incorporated
Project Architect: Markus Dochantschi
Design Team: Ed Gaskin, Ana Sotrel, David Gerber, Jan Hübener, Christos Passas, Sonia Villaseca, James Lim, Jee- Eun Lee, Oliver Domeisen, Helmut Kinzler, Patrik Schumacher, Michael Wolfson, David Gomersall
Construction Manager: Turner Construction Company.
Structural Engineers: THP Limited, Inc., Cincinnati.
Acoustic Consultant: Ove Arup and Partners, New York.

Total area: 80,000 square feet

Date of completion: 2003

INTRODUCTION
Rosenthal centre for contemporary art is the first freestanding building for The Contemporary Arts Center, founded in Cincinnati in 1939 as one of the first institutions in the United States dedicated to the contemporary visual arts which represents a fresh and unpredictable forward

looking structure in its cubic state. The structure features volumes of jutting forms within the composition.

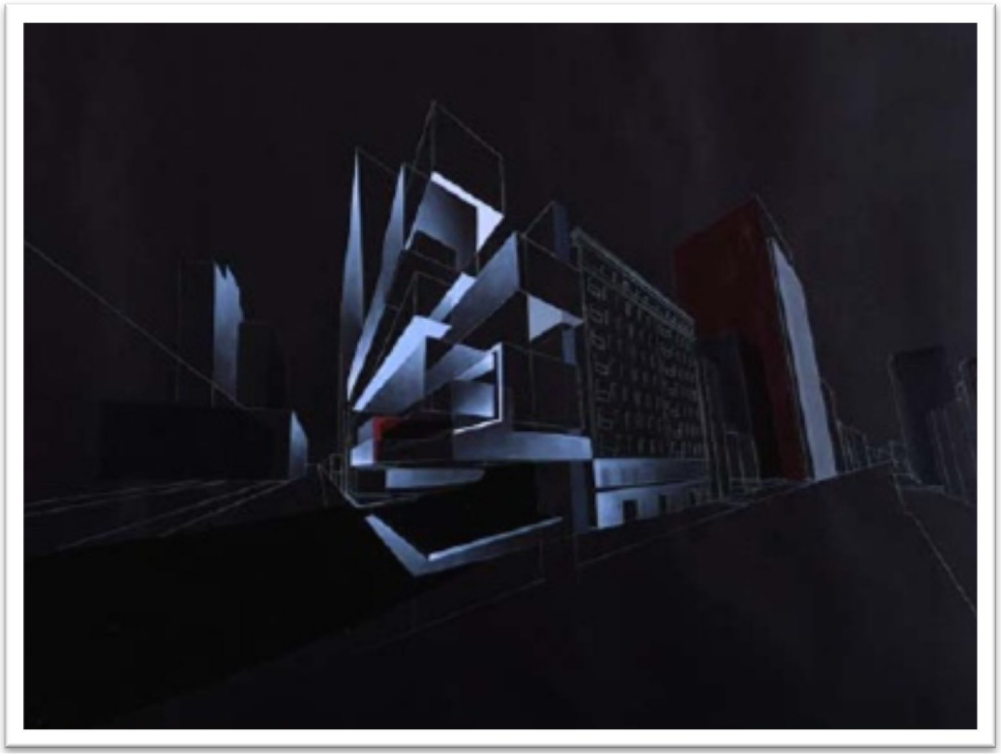


Plate 4.54; Rosenthal center for contemporary art, Cincinnati
Source; Helene Binet (2011)

VARIABLES

MAJOR FACILITIES	DOMINANT BUILDING MATERIALS	USE OF ARTIFICIAL LIGHT	DAYLIGHT ELEMENTS USED	BUILDING'S ARCHITECTURAL FEATURES AND CHARACTERISTICS
-Museum -Children's education center -Performance space -Bookstore -Museum shops -Boardroom -Workshop/studios -Office facilities -Auditorium --Galleries (permanent and temporary) -Library and media library -Cafe	- Concrete -Steel -Glass	Artificial light was introduced in the interior especially areas where daylight could not reach due to the dynamism of the building's composition.	-Glazed glass Glazed glass was used on the ground level entrance facade and at different portions of the building.	-Urban Carpet The entrance, lobby and lead-in to the circulation system are organized as an "Urban Carpet." Starting at the corner of Sixth and Walnut, the ground curves slowly upward as it enters the building, rising to become the back wall. As it rises and turns, this Urban Carpet leads to a suspended mezzanine ramp through the full length of the lobby, which during the day functions as an open, daylit, "landscaped" expanse. The mezzanine ramp continues to rise till it penetrates the back wall, on the other side of which it becomes a landing at the entrance to the galleries. - Jigsaw Puzzle The galleries are expressed as if they had been carved from a single block of concrete and were floating over the lobby space. Exhibition spaces vary in size and shape, to accommodate the great range of scales and materials in contemporary art. Views in the galleries from the circulation system are unpredictable, as the stair-ramp zig-zags upward through a narrow slit at the back of the building. - Skin/Sculpture: The south facade, along Sixth Street, forms an undulating, translucent skin, through which passersby see into the life of the Center. Offices are organized along this side to provide daylit working environments and views of the city; providing the facade with human animation. The east facade, along Walnut, is expressed as a sculptural relief. It provides an imprint, in negative, of the gallery interiors.

Table 4.9: Case study of the Rosenthal center for contemporary art, Cincinnati
Source: researcher (2011)

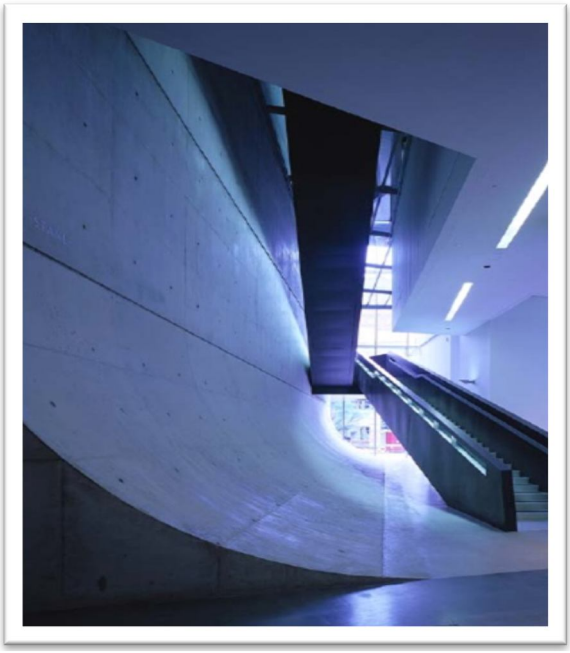


Plate 4.55: View showing influx of daylight through the movement of ramp
Source; Helene Binet (2011)



Plate 4.56: view showing the ramp
Source; Helene Binet (2011)



Plate 4.57; Rosenthal center for contemporary art, Cincinnati
Source; Helene Binet (2011)

1.1 4.12 SUMMARY OF FINDINGS FROM CASE STUDIES

TABLE 4.10: CASE STUDIES SUMMARY

CASE STUDY	MAJOR FACILITIES	DOMINANT BUILDING MATERIAL	USE OF DAYLIGHT ELEMENTS	USE OF ARTIFICIAL LIGHT	BUILDING'S ARCHITECTURAL FEATURES AND CHARATERISTICS
Cyprian Ekwensi art and cultural centre, Abuja	This art centre has facilities required in an art centre for visual and performance art.	The major building material is concrete. Steel and glass is also used.	Daylight elements used were mainly side lighting (windows) which was just sufficient for seeing	Electric lights were in use extensively. Tungsten bulbs were used.	The building attempts to use contemporary architecture with artistic representation on the walls and pillars.
Nike art centre, Abuja	The centre has facilities for visual art and no particular facility for performance art.	Sandscrete blocks are used.	The elements used were just windows which provide daylight for just viewing. No special considerations were made for the influx of daylight which exposes the art works to effects of glare and ultraviolet ray.	The centre uses lots of artificial light for lighting in all the sections of the building complex	The building depicts a mixture of traditional architecture and artistic works were done the external walls which symbolizes the use of the building.
Kimbell Art Museum, Taxas	The Museum has facilities for mainly exhibitions of visual art works	Concrete walls and barrel vault	There was extensive use of day light in the museum through top and side lighting.	The use of artificial light is provided for night use.	The building consists of a series of parallel, cycloidal concrete shells in the form of barrel vaults with a counterpoint of three interior courts.

High Museum of Art, Atlanta	The museum has facilities for both visual and performance art.	Concrete glass and steel was used	Daylight was extensively incorporated such as Rooftop-sails and Mini skylight diffuses into the gallery. The daylight elements used are adjustable to suit the need of the exhibit.	Artificial light was provided for use at night and day where necessary	The granite plinth of the building acts as a horizontal datum for the ramps and, in elevation, as an anchor for the white porcelain-enameled steel panels.
North-Carolina Museum of Art	The facilities in the museum are mainly for visual art.	It consist of Concrete frame, glazed glass & precast concrete barrel vault roof	Daylight was sufficiently used in this Museum. Glazed glass was extensively	Artificial light such as electricity is used together with daylight.	The museum design incorporate fluid movement in the museum in order to avoid traffic
Contemporary art museum St. Louis	There is provision for only visual art	Use of precast concrete and glass.	Daylight was used in areas such as corridors, stairs and other areas other than places where major exhibits are displayed	Artificial light was provided for use at night and day where necessary	The museum building is formed by two opposing walls of concrete, which intertwine and are cantilever.
Maxxi-national centre of contemporary arts, Rome	There is provision for visual and performance art. The centre has 90% of facilities needed for an art centre	Use of precast concrete and glass.	Skylights, atrium and glazed windows were used to enhance viewing of art works	Artificial light was provided for usage especially at night.	The variety and interweaving of spaces and the modulated use of natural light lead to a spatial and functional framework of great complexity, offering constantly changing and unexpected views from within the building and outdoor spaces.

Rosenthal centre for contemporary art	There is provision for visual and performance art. The centre has 80% of facilities needed for an art centre	Use of precast concrete and glass	Daylight elements were not used in the galleries very much. The elements were used in other spaces in the centre such as glazed windows.	Artificial light was introduced in the interior especially areas where daylight could not reach due to the dynamism of the building's composition	The structural composition of the art centre features volumes of jutting forms within the composition.
Conclusion	An attempt is made to incorporate both visual and performance art.	Prominent use of precast concrete, glass and steel	Daylight is used in one way or the other, either as the main source of illumination or to compliment other sources of light used.	Artificial lights are used either to complement the daylight or to serve as the major source of lighting	-The buildings tends towards being artistic. -The spaces exibit a concept of movement that transits from one space to another without traffic.

4.13 RATING BASED ON THE ASSESSMENT OF APPLICATION OF DAYLIGHTING TO ARTIFICIAL LIGHTING

This rating is done based on the type and amount of daylight strategies used in the buildings.

Table 4.11: SUMMARY TABLE

CASES	DAYLIGHTING	ARTIFICIAL LIGHT
STUDIES	**High** **Medium** **low**	**High** **Medium** **low**
Cyprian Ekwensi art and cultural centre, Abuja	★	★★
Nike art centre, Abuja	★	★★
Kimbell Art Museum, Taxas	★★★	★

High Museum of Art, Atlanta		
North-Carolina Museum of Art		
Contemporary art museum St. Louis		
Maxxi-national centre of contemp-orary arts, Rome		
Rosenthal centre for contemporary art		

4.14 CASE STUDY FINDINGS

i. From all the case studies, it can be seen that there is an attempt to provide daylight through top lighting and side lighting in art centres in Nigeria and internationally.

ii. The materials used for finishing were mostly light coloured and thus good reflectors of light.

iii. Architecture of Art centres and museums display a demonstrative gesture in abstract composition of sublime forms.

iv. Art centres display clear, elegant, simplicity and complexity in use of forms showing the structure as a work of art.

v. In the Nigerian case studies, double banking of the art centre was common thus illumination was from one direction only.

vi. From the Nigerian case studies, in case of power outage, the interior of the art centre becomes dark and it becomes difficult to see.

vii. The Nigerian case studies make an attempt to incorporate both visual and performance art.

4.15 CASE STUDY INFERENCES

i. A good day lighting design, requires day lighting to be an integral part and not just an addition via windows or glazing.

ii. Use of reflected light in the exhibition spaces and galleries will not deteriorate the quality of the art works on display due to exposure to glare and ultraviolet ray

iii. A careful selection of building materials can enhance day light in the interior environment of buildings such as paint colour.

iv. A good selection of building materials should not affect the thermal environment.

v. A combination of day lighting elements and artificial lighting will ensure well day lit spaces during the day and a smooth transition to artificial lighting during the night.

vi. Good and careful use of top lighting and side lighting is recommended for the design of such a facility.

CHAPTER FIVE

DESIGN CRITERIA

5.1 INTRODUCTION

The focus of this chapter is on the design or the yardstick of information and data which would eventually form the benchmark for the design of the Art Centre.

5.2 SITE LOCATION

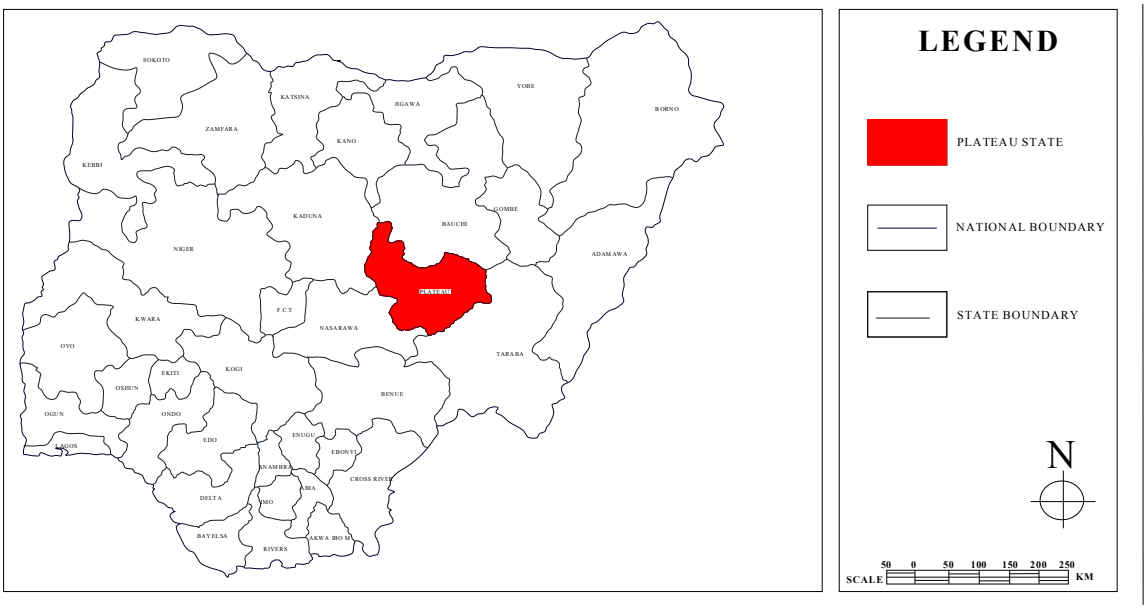


Fig 5.1; Map of Nigeria showing the outline of Plateau State
Source; Researcher (2012)

5.2.1 Brief description of Plateau State

Plateau State is located in Nigeria's middle belt region having adjacent states such as Bauchi State at its north-east, Kaduna State at its north-west, Nasarawa State at its south-west and Taraba State at its south-east. Plateau state has an area of 26,899 square kilometres; the State has an estimated population of about three million people. It is located between latitude 80°24'N and longitude 80°32' and 100°38' east. The state is named after the picturesque Jos Plateau, a mountainous area in the north of the state with captivating rock formations. Bare rocks are scattered across the grasslands, which cover the plateau. The altitude ranges from around 1,200 meters (about 4000 feet) to a peak of 1,829 metres above sea level in the Shere Hills range near Jos.

5.2.2 Site location

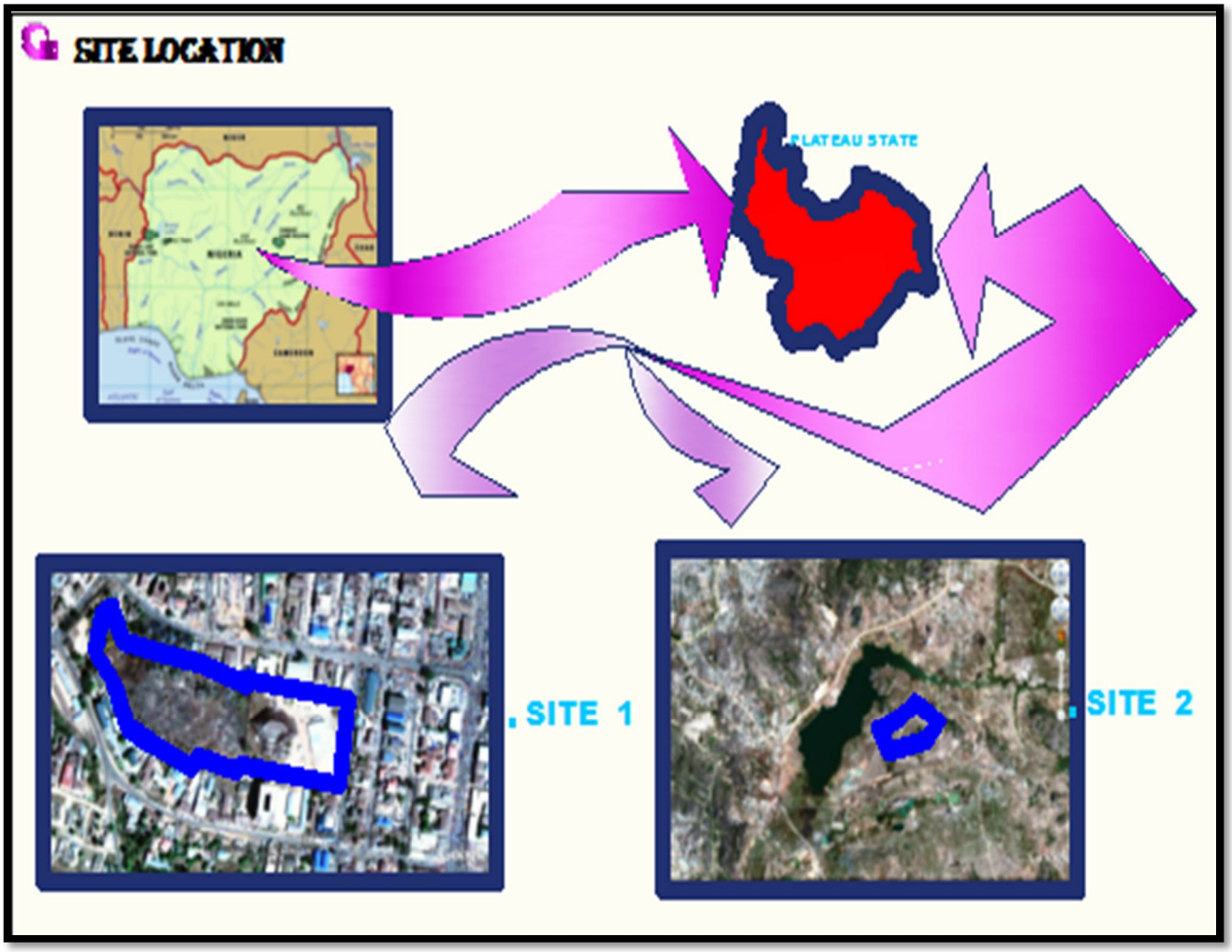


Fig 5.2; Google image of the two sites that will be considered
Source; Researcher (2012)

5.3 SITE SELECTION CRITERIA

Site selection is an important aspect of passive design because the site must provide the adequate resources from the weather to the facilities surrounding the site that will aid the functioning and well patronage of the art centre. Therefore, two sites are considered below and the one with the better resources will be considered for development. Below is a list of site selection criteria that will be used for the selection of site.

- The ecological characteristics of the site.
- The site's climatic characteristics to support passive lighting
- The site's special cultural significance.

- The site's nearness to existing infrastructure such as roads, power lines, water supply and waste disposal sites.
- The state of the environment of the site.
- The influence of future land-use plans for the areas surrounding the site.
- Easy access to the destination
- The potential of the site to support and provide easy patronage of the facility.

These site selection checks have been used to compare and evaluate the appropriateness of site one to site two for usage and are summarized in table 5.1. The rating is represented as such;
Excellent = 5
Very good = 4
Good = 3
Fair = 2
Poor = 1
Very poor = 0

5.3.1 Site selection criteria table

S/N	CRITERIA	Site 1: Tafawa Balewa road site	Site 2: Lamingo dam site	Remarks
1.	The ecological characteristics of the site	4	5	The soil will be able to withstand load
2	The site's climatic characteristics to support passive lighting	5	3	The site will provide enough light for the passive design
3	The site's special cultural significance.	4	3	
4	The site's nearness to existing infrastructure such as roads, power lines, water supply and waste disposal sites.	5	2	Site 1 is the one closest to existing infrastructure and utilities
5	The state of the environment of the site.	4	3	
6	The influence of future land-use plans for the areas surrounding the site.	5	3	Site 1 was specially designated for design of an art centre
7	Easy access to the destination	5	3	Easy access by road
8	The potential of the site to provide	5	4	The location of site 1 within

	easy patronage			the city will aid patronage
	TOTAL	37	26	Site 1 is best for the purpose

Table 5.1; A check list table for site selection
Source; Researcher (2012)

5.4 SITE ANALYSIS

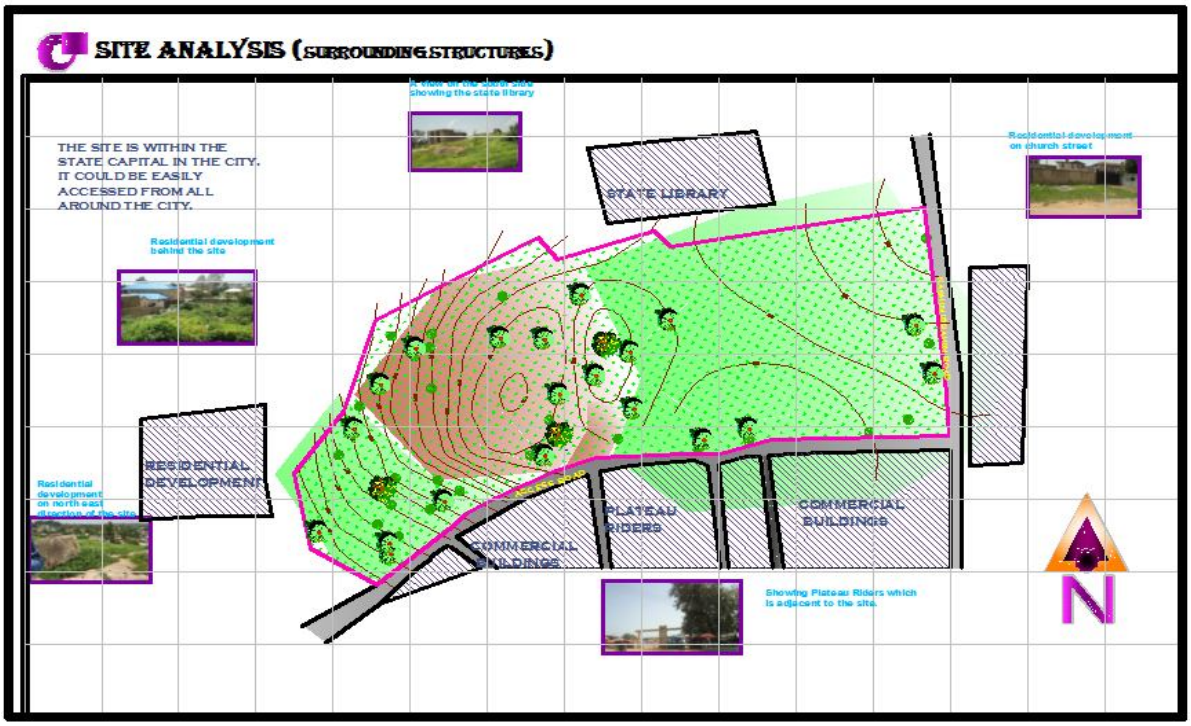


Fig 5.3; Site analysis showing surrounding facilities around the site
Source; Researcher (2012)

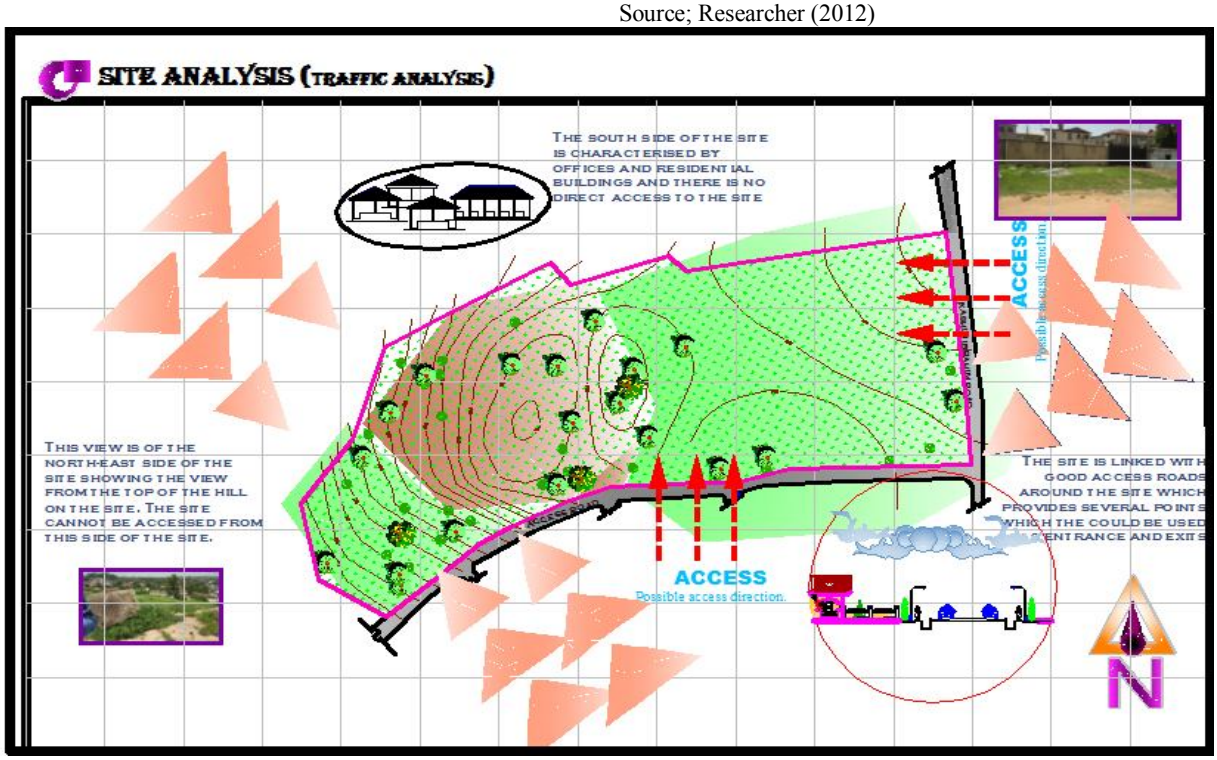


Fig 5.4; Site analysis showing traffic analysis
Source; Researcher (2012)

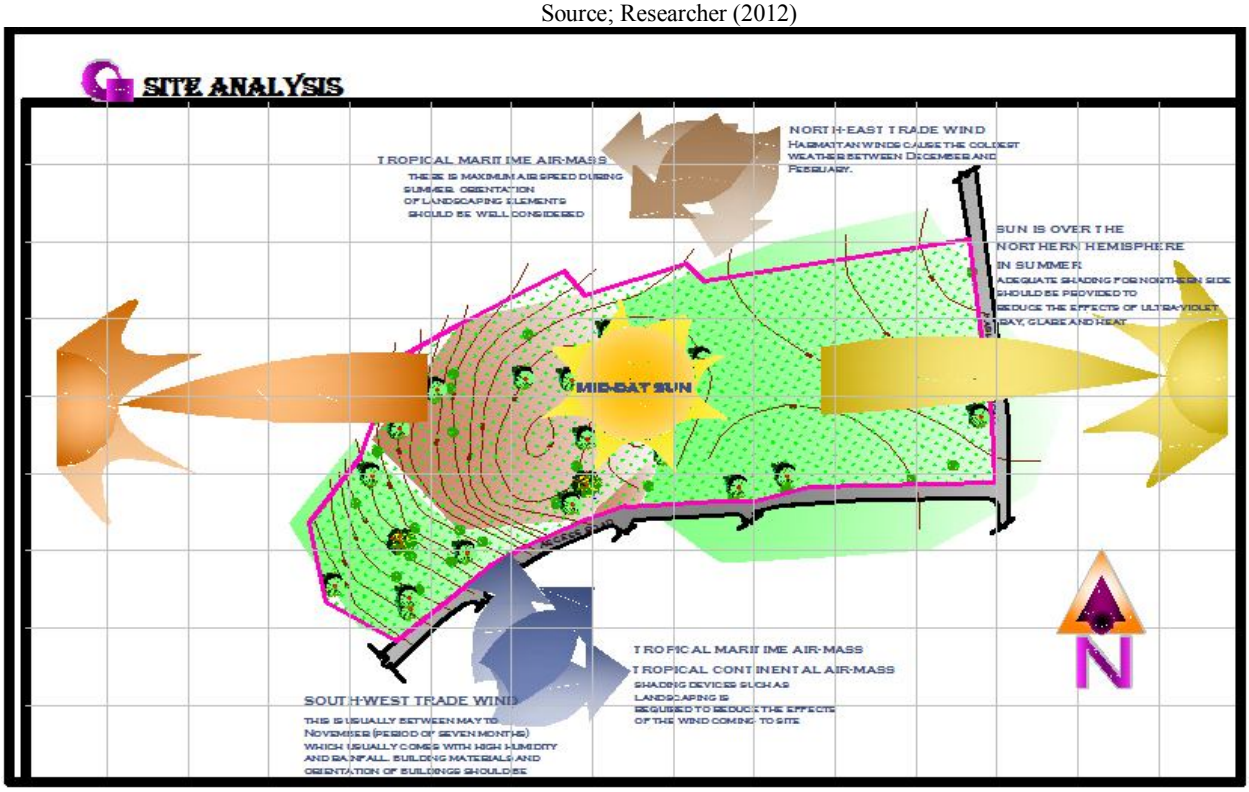


Fig 5.5; Site analysis showing sun and wind direction
Source; Researcher (2012)

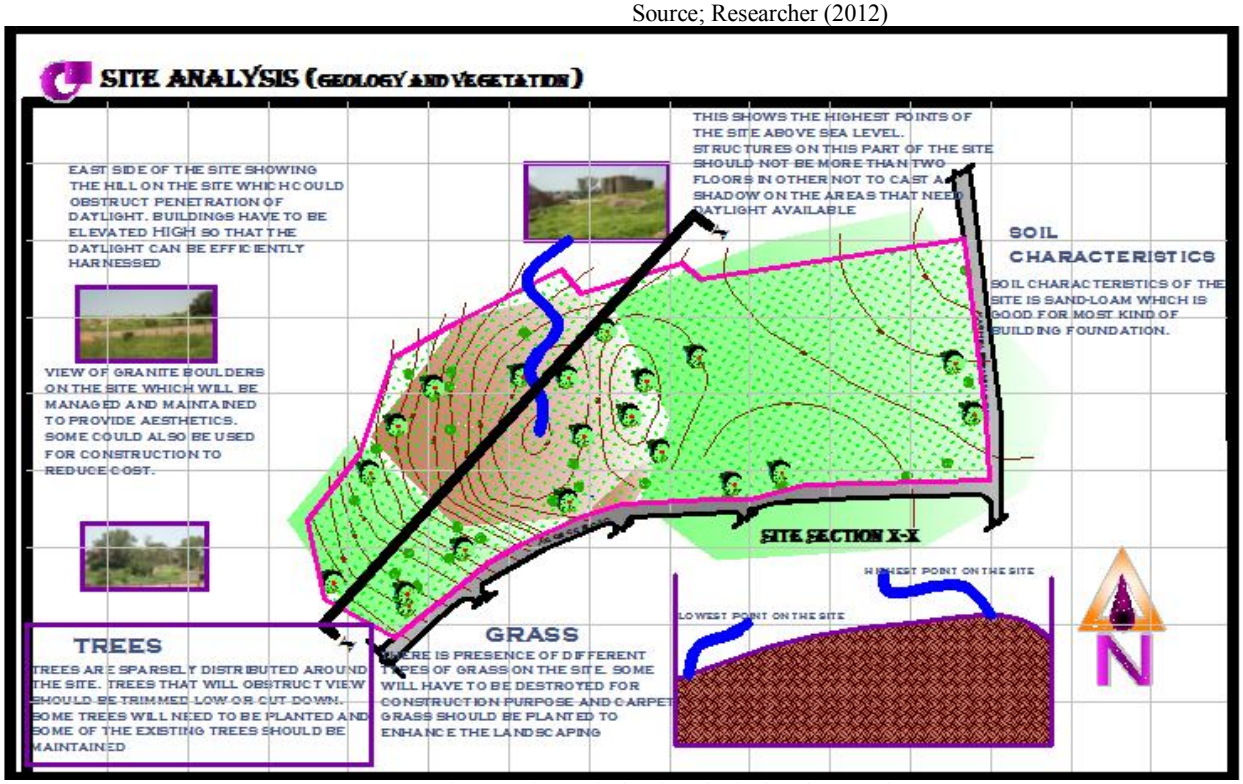


Fig 5.6; Site analysis of geological and vegetation
Source; Researcher (2012)

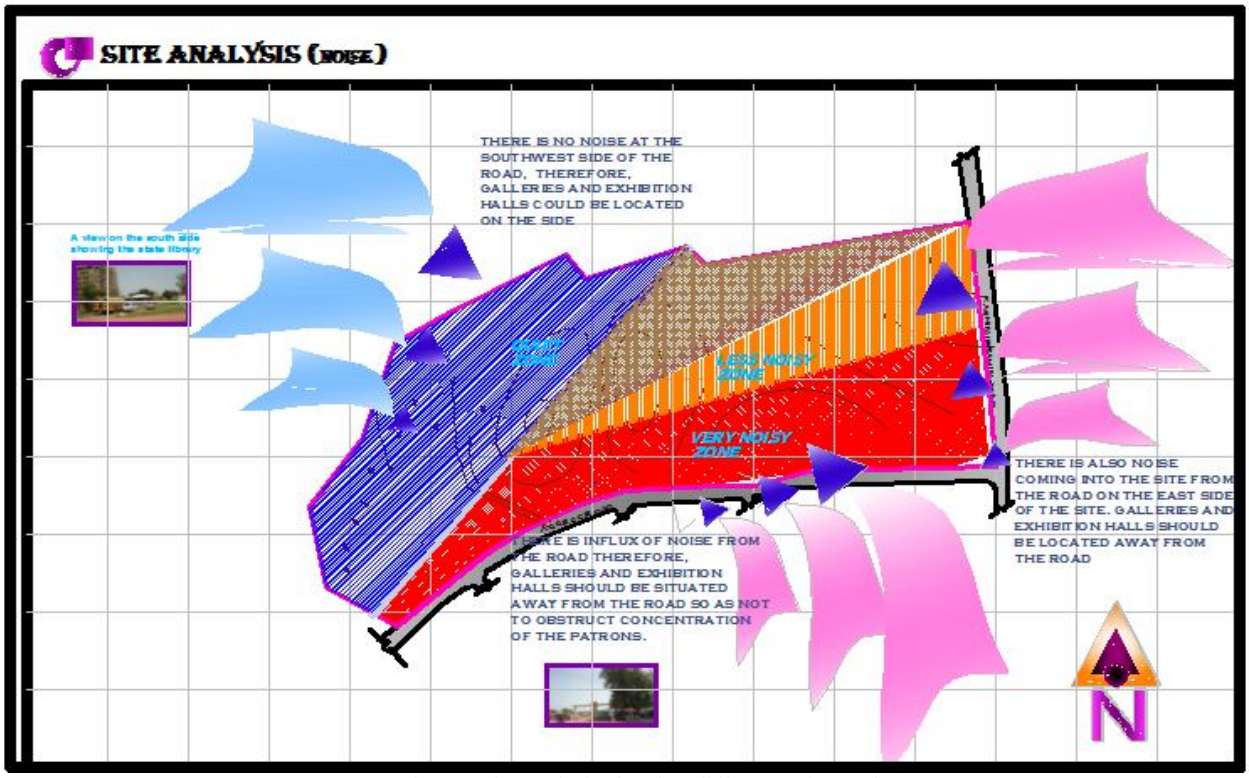


Fig 5.7; Site analysis showing different noise zoning
Source; Researcher (2012)

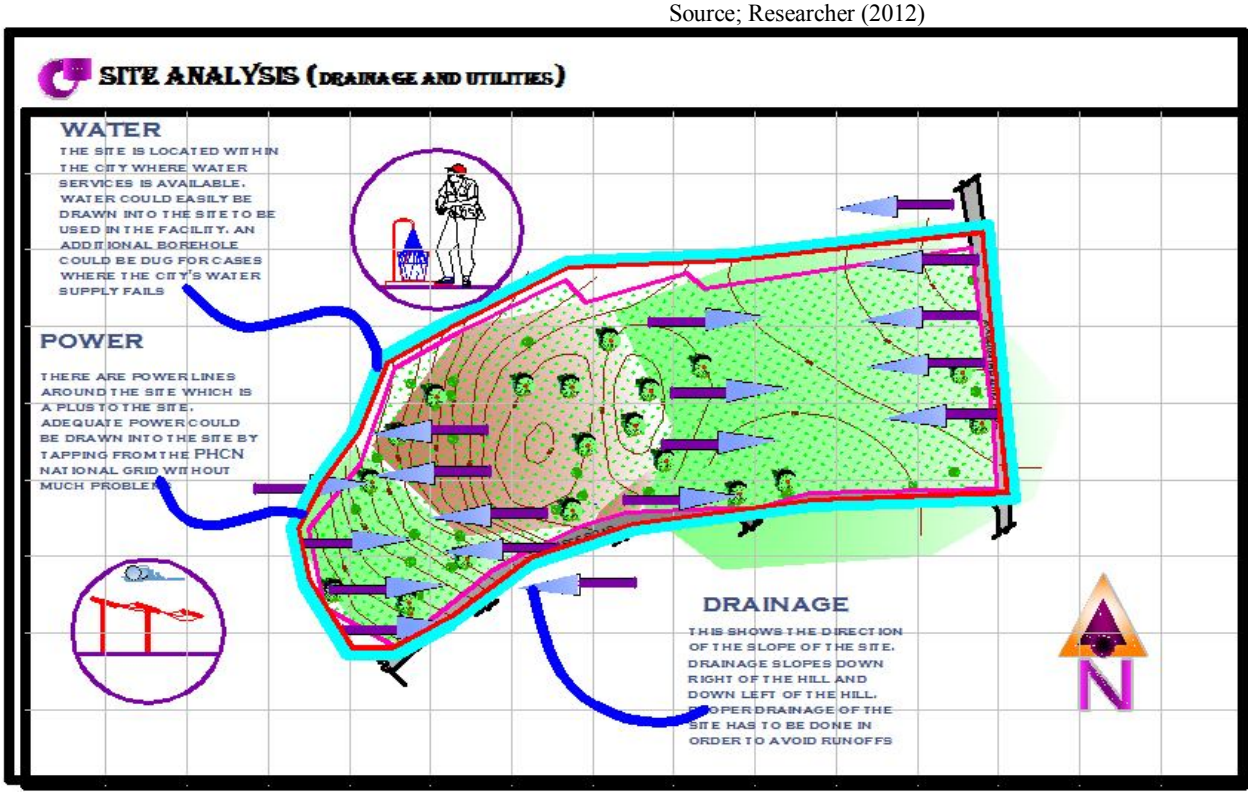


Fig 5.8; Site analysis of drainage and utility
Source; Researcher (2012)

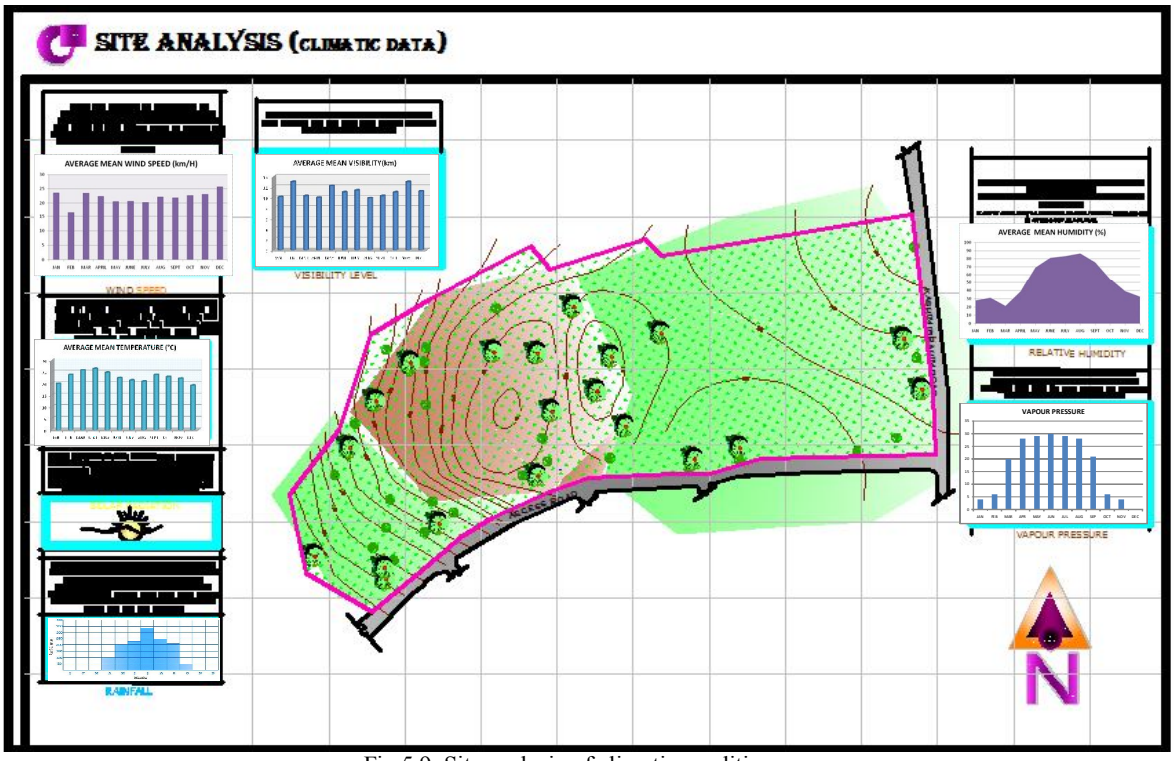


Fig 5.9; Site analysis of climatic condition
Source; Researcher (2012)

5.5 CLIMATIC ANALYSIS

Average mean temperature

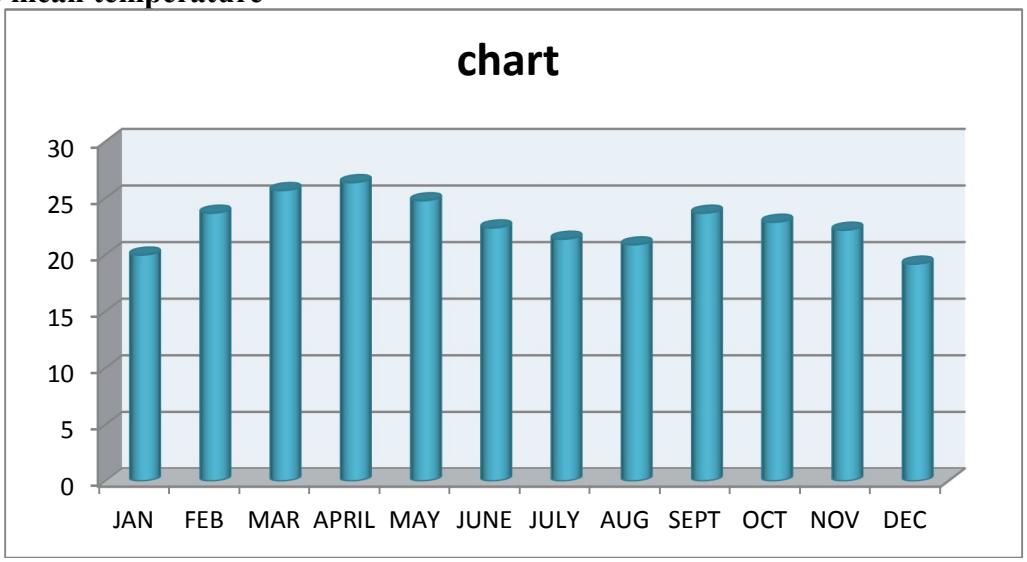


Fig 5.10; Mean temperature of the site
Source; Tutiempo.net (2012)

Average mean humidity

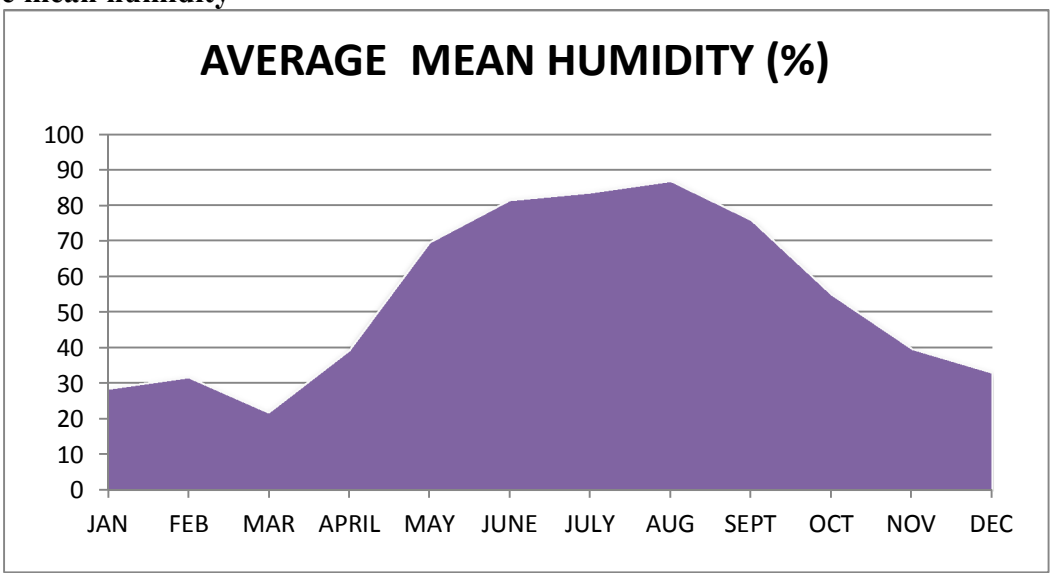


Fig 5.11; Relative humidity
Source; Tutiempo.net (2012)

Average mean visibility

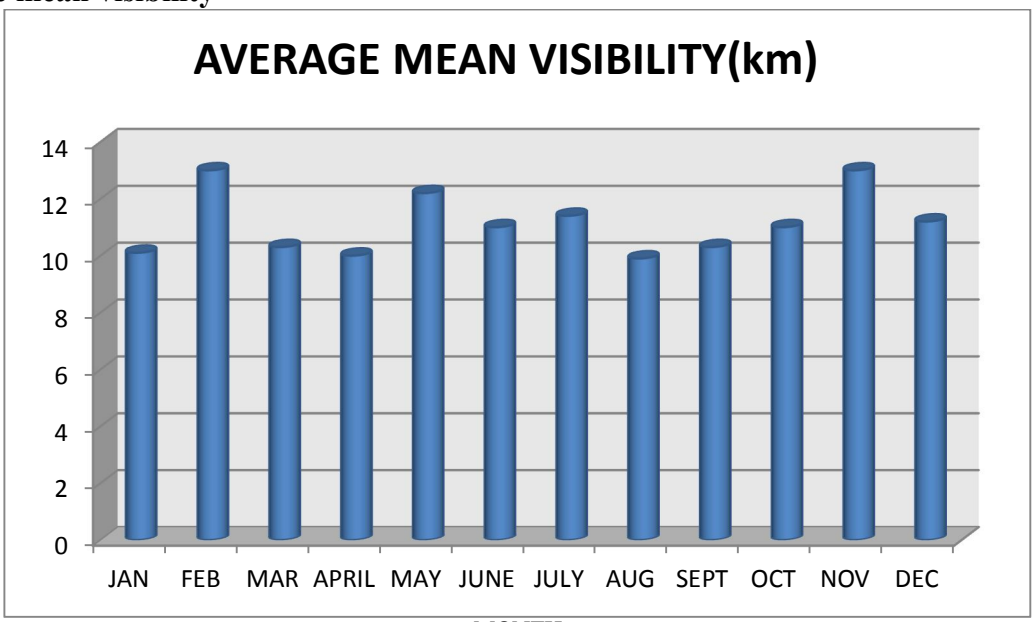


Fig 5.12; Mean visibility
Source; Tutiempo.net (2012)

Average mean wind speed

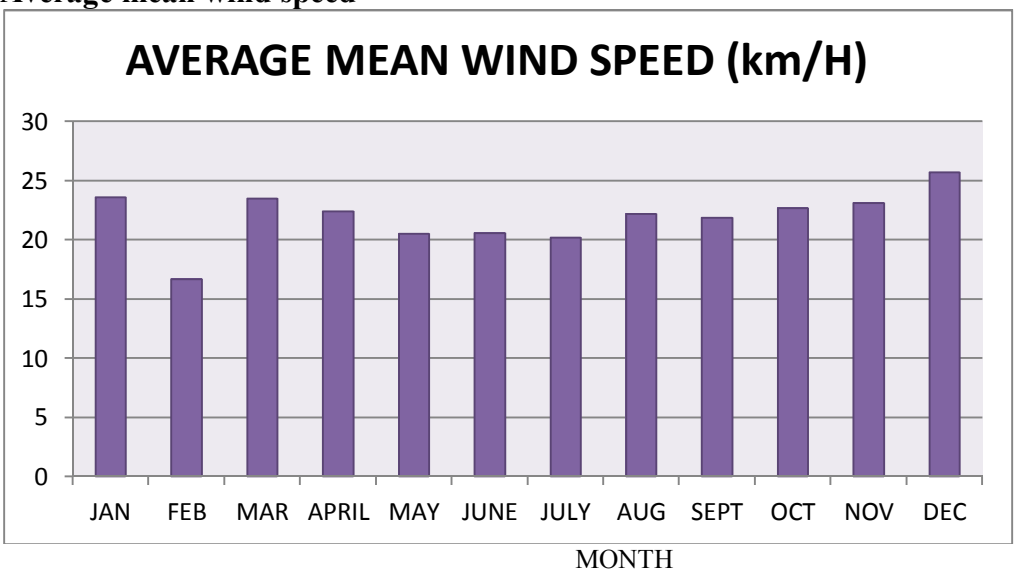


Fig 5.13; Wind speed
Source; Tutiempo.net (2012)

Rainfall

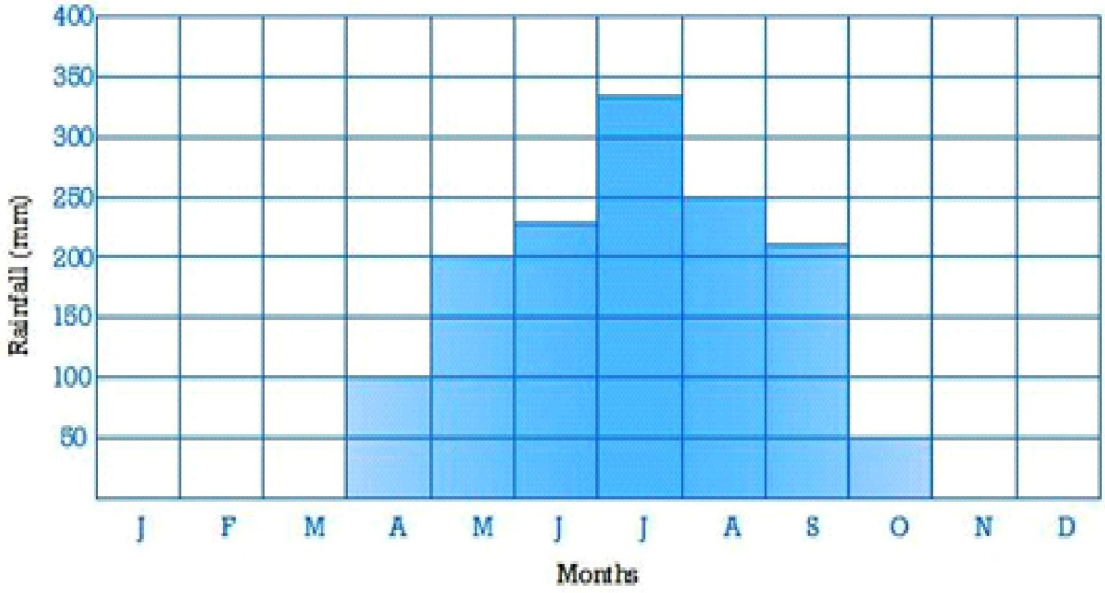


Fig 5.14; Rainfall
Source; Tutiempo.net (2012)

CHAPTER SIX
DESIGN BRIEF

6.1.1.1.1 6.1 BRIEF DEVELOPMENT

Client: The client is a merger of the following organisations:

i. The Nigerian gallery of art (Under the Federal Ministry of culture and tourism)

ii. Society of the performing arts in Nigeria (SPAN)

The Nigerian gallery of art wishes to have an art centre located in Plateau State capital, Jos. The client of the proposed national art centre is intended to cater for activities such as exhibitions, educational functions, conferences, performing arts-dance, and other social activities for the smooth running of the art centre; thus the spaces and facilities proposed are designed to comply with the scope of the project. The site is located opposite Plateau Riders along Kashim Ibrahim Street.

This brief aims to encompass the following:

1. A provision of art entertainment and viewing sections for education and pleasure.
2. A careful integration of unemployed but talented youth into the programmes of the facility
3. The functional requirements of artist production areas shall be rationally included into the design.
4. The centre shall be economically viable and sustainable.
5. The design will allow for interaction on all the aforementioned levels. It is believed that interaction shall enhance learning within the centre; especially the youths.
6. A provision of avenue for art exhibitions and symposia
7. Circulation spaces within the premises will be defined and provide natural access control to avoiding interfering with the landscape
8. The use of highly durable and low maintenance building materials
9. Segregation of sections
10. Layout should follow the site slope
11. Impermeable construction materials that will provide good rain protection

The proposed spaces are based on specific activity types as well as the staffing system or organogram of an art centre.

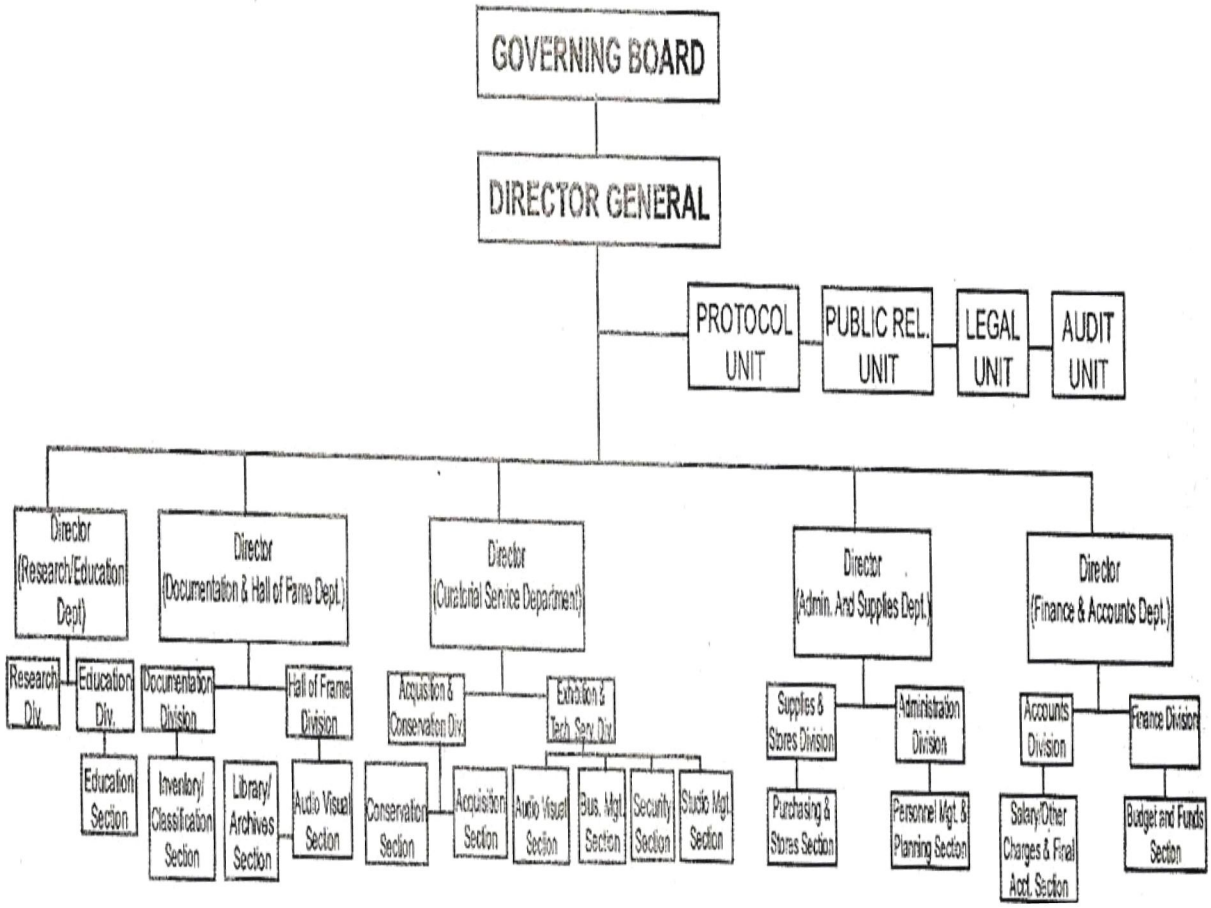


Fig 6.1; Oragnogram for the national art centre
Source; Researcher (2012)

6.2 PROPOSED FACILITIES

i. Art galleries

a) Galleries

b) Exhibition halls

ii. Design centre

a) Multipurpose studio

b) Fine art studio

c) Children studio

d) Photography studio

e) Architectural studio

iii. Art and craft workshops

f) Sculpture workshop

g) Pottery workshop

h) Metal/ wood/ glass workshop

i) Fabric and leather workshop

iv. Presentation unit

a) Theatre

b) Multipurpose hall

v. Administrative unit

a) Office Accommodations for staff.

b) Conference room

vi. Preservation and documentation unit

a) Library and resource centre

b) Preservation and restoration

vii. Ancillary facilities

a) Restaurant

b) Maintenance and services

c) Shops

d) Art village

6.3 DESCRIPTION OF SPACE

1. ART GALLERIES

The art galleries will include exhibition halls and spaces, showcase rooms and museum spaces which will be located in the main building complex. These will be designed to showcase local arts and crafts of all kinds of culture and other artifacts. The art gallery will be designed as flexible open spaces the form of halls and passages whereby viewers can have a smooth and easy transition from one exhibition space to another.

2. **DESIGN CENTRE**

The design centre is a space where art design will be done and taught to patrons who are novice in fine art. The design centre will include a fine art studio, children studio, architectural studio and a general studio. These studios will be well lit to provide adequate lighting for the purpose which they will be used.

3. **ART AND CRAFT WORKSHOPS**

These are spaces that will be used for the production of art works such as sculptures, pottery, metal works, wood woks, glass works, leather and textile works. Spaces will be adequately provided for such activities away from the galleries in order to prevent noise from affecting viewer's concentration and enjoyment.

4. **PRESENTATION UNIT**

The presentation unit will include a theatre and a multipurpose hall. The multipurpose hall will be provided for lectures and small-time drama presentation and can serve as a cinema. The theatre will be designed for indoor stage performing arts such as music, dance, and drama. This unit will also have the following facilities:-

i. Performing Stage
ii. Control room
iii. Changing room for artists
iv. Storage rooms for costumes, equipments, props and so on.
v. Water closets for artist and audience
vi. Ticket office
vii. Snack bar

5. **ADMINISTRATIVE UNIT**

This unit will provide spaces for office accommodation of the staff that will oversee the running of the art center. The administrative unit will contain offices, staff lounges, tea rooms, orientation rooms, board room and a reception area. The capacities of the office will be determined based on the organogram of the national art center.

6. **PRESERVATIONA AND DOCUMENTATION UNIT**

This unit will include a library, resource centre and an internet cafe. This will provide reading and research facilities for visitors. The library will have mostly art materials in shelves for the general public use.

7. **ANCILLARY FACILITIES**

These are facilities that compliment the art centre. They include; Restaurant

a. **Restaurant:** This will include the main dining hall and an outdoor dining area; a kitchen and store.

b. **Maintenance and services:** This will be a separate unit from the main building which will provide accommodation for the maintenance of the structure and arts and crafts works that are not in good condition within the center.

c. Shops: These are retail shops that art works will be sold to patrons. The shops will be located close to the workshops so as to easily transport art works that are meant for sale.

d. Art village: The art village will be provided to create an avenue for youths to meet and interact and exchange artist ideas and views, also to exhibit their artistic talents. The art village will be located on the hill locates in the site. The spaces will be well landscaped for relaxation.

6.2 6.4 DESIGN CONSIDERATION

Art centres attract large amount people ranging from artist, performers and viewers. If this is to be properly catered for, then it is expected that the architect should properly resolve scale, orientation and circulation.

1. **Scale:** the proportionality of elements and the overall form of the buildings should be such that they conform to their environment. It is believed that when buildings are large and disproportional they might exert an unpleasant domineering effect.
2. **Orientation:** the dynamism of a building is determined by its orientation (Fadiman, 2006). The way in which one flows through varying spaces is a factor of the orientation.
3. **Circulation:** Adequate circulation patterns ensure pleasurable experiences within art centres. It is of utmost importance that the transition spaces allow for easy flow between spaces.

6.2.1 6.5 LIGHTING

There are two major types of interior lighting, namely;

1. Daylighting
2. Artificial lighting

For the purpose of this design, visual perception is of utmost importance.

A good combination of both lighting types allows for a variety of results, thus ensuring that the interiors boast of wide array of experiences. It is for this reason that the design incorporates both types.

6.5.1 DAYLIGHTING; Daylighting is essential as a result of the epileptic power supply in the state (Plateau State). It is also required because lighting conditions are modulated throughout the day. Day lighting allows for the following:

1. Day lighting permits excellent colour discrimination and rendering which are essential in art galleries.

2. Increased user productivity; Day light enlivens a space and increases user satisfaction and visual comfort. It also results in less optical strain and discomfort. (Ander, 2008)

3. It provides relaxing exterior views from within interior spaces (Fadiman, 2006).

4. The human eye sees better in natural light and day light provides high illuminance that is adequate for seeing.

5. It allows for an intricate blend of lighting conditions within interiors, thus creating a variety of experiences, if properly harnessed.

6. The experience of the world beyond the building, by the view to the outside, whilst this is associated with the factor of orientation, it has the added aspect of content which can be of open countryside, trees and landscape, but more often than not of other buildings and street patterns (Philips, 2004).

Control of Natural lighting is essential so as to avoid damage of exhibits by ultraviolet (UV) rays, glare and unwanted reflection thus, the need for daylighting systems which includes;

a. Use of laminated glass for all fenestration on the building complex

b. Use of light-wells

c. Clerestory

d. Reflective blinds

e. Use of monitor roof

f. Tilted reflective surfaces

g. Use of Light shelves which allows for controlled reflected light into the spaces

h. Use of tubular skylight also known as light tubes into exhibition spaces

i. Transparent insulation

j. External reflectors

k. Use of atriums and other roof lights

6.5.2 ARTIFICIAL LIGHTING: Is a means of lighting through mechanical means to generate electricity. Artificial lighting allows for wider control and array of modulation. The means of artificial lighting adopted include:

1. Task lighting: involves all utilitarian lights which serve functional purposes. They include lighting within studios and Restaurants.

2. Accent lighting: These are used to attract attention or to lay focus and emphasis. This is mainly adapted to exhibition spaces. They include flood lighting, down or up-lighting and spot lighting. They can also be used to highlight edges, faces and boundaries of spaces.

3. Mood lighting: these are used in most spaces, so as to create different mood stimulation. They are used as illusionary, atmospheric and decorative lighting within spaces so as to alter

stimulation of such spaces. They can be used to create awareness, rest and other moods along corridors, galleries and restaurants. This lighting type is used in close relation to colour schemes.

4. Modulated lighting: These are used to define shapes form, scale and space. This lighting type allows for a variety of perception. Most large spaces such as exhibition spaces require bright lights and colours so as to create a feeling of comfort and reduce overcrowding.

6.2.2 6.6 CLIMATIC CONTROL

For preservative reasons, most Exhibits require controlled climatic elements so as to reduce their rate of deterioration. Certain temporary exhibits can be exhibited, within short periods under normal atmospheric conditions.

The main gallery spaces shall be of controlled atmospheric conditions, while auxilliary facilities shall rely on minimal atmospheric conditioning. The atrium shall be used to create 'stack-effect' for the main building; acting as a ventilation enhancer for adjoining spaces.

i. **Temperature:** the temperature of Plateau State ranges from 18° to 27°. Artworks require constant temperature of 21^{o}c (with a 2 degree variation), a drop in temperature is highly essential. The use of deep roofs shall be used alongside minimal mechanical systems to reduce the high temperatures.

ii. **Relative humidity:** Artworks require about 50% humidity (with a 5% variation) in order to enhance their preservation. During the rainy season, relative humidity in plateau state can go as high 85%, but this is rather rare. The dry season is of utmost importance as it is of a longer duration. The relative humidity can go as low as 25%. Ventilation of interior exhibition and storage spaces shall be of utmost importance during the rainy season.

iii. **Solar radiation:** Ultraviolet (UV) rays from the sun increase the rate of deterioration of art works. It for this reason that adequate daylighting systems shall be employed.

6.2.3 6.7 NOISE AND DUST CONTROL

The level of noise within the art galleries and exhibition spaces shall be reduced to a bearable minimum, with proper zoning and use of non-reflective and sound absorbing materials. Noise sources include conversations, movement, equipments, air conditioning plants, human interaction within studios and from surrounding facilities around the site. The galleries and exhibition spaces shall be located along the north-east of the site.

Since visual contact is to be ensured, laminated glass shall be used. Laminated glass is composed of two or more layers of glass with one or more layers of a transparent/ pigmented and specially treated plastic Polyvinyl Butyral [PVB] sandwiched between the glass layers. The glass panes (layers) can be either normal glass or tempered glass. Laminated glass has the following properties;

- Laminated glass is an excellent barrier to noise. The sheer damping performance of the plastic interlayer makes laminated glass an effective sound control product.
- Ultraviolet light is the leading cause of deterioration and fading of furnishings, pictures, and fabrics. Laminated glass screens out 99% of the sun's UV radiation, protecting displays or exhibits from fading.
- Laminated glass retains its colour and strength for the life of the building and is as easily cleaned as any conventional glass.

Dust control is essential within gallery and storage spaces. The use of windbreakers such as trees shall be used to reduce dust infiltration within gallery spaces. Air conditioning shall also help reduce this menace.

6.2.4 6.8 DISPLAY TECHNIQUES.

Exhibits shall remain the focal point of the design. It is important to keep the audiences' attention for as long as possible. This can only be achieved using interesting and energizing techniques and keeping the exhibits within the human visual field.

The most effective display technique allows for exhibit to be viewed individually, even though a cluster of exhibits might be arousing or increase attention.

Display techniques employed shall include:

i. **Walls:** These shall be used as major display surfaces, especially for flat exhibits such as paintings and murals. They allow for easy modification and alterations both in terms of colour and texture. This will ensure that experiences are varied over time, thereby reducing the tendency for the spaces to be redundant and boring. The use of curvilinear walls shall be employed to create a feeling of transition. The use of walls is kept to the bearest minimum; as a good percentage of nigerian art pieces exist as 3-dimensional objects that require movement around them.

ii. **Panels:** These serve similar functions as walls, but are more flexible. They allow alteration of space composition. Panels can take various shapes and forms, with their own lighting and colour control. Suspended panels shall be provided for through the central void over all floors. For proper design of panels, consultations shall be made with exhibition experts. There shall be a significant reliance on panels as opposed to walls.

iii. **Cases:** These are used to protect valuable and permanent exhibits from theft and damage.

iv. **Ceiling:** These can be used to stimulate attention for short periods, in a similar way as walls.

v. **Outdoor exhibits:** These are lit naturally during diurnal activities. They require support and protection and should be exhibited temporarily. Permanent outdoor exhibits should be made extremely durable; examples include concrete and steel sculptures.

6.9 SAFETY PRECAUTIONS.

Since the facility is people oriented, it is essential that the safety of lives and property be adequately catered for.

The following considerations were made:

1. **Fire hazards:** Provision was made for stair halls that open directly into the exterior so as to ensure that such spaces allow for easy evacuation of persons and removal of smoke. Also, staircases are designed such that their treads and risers are within standard ranges for easy use.

   Provision of escalators and ramps that allow for easy use by all persons is provided. All areas that are prone to fire outbreaks shall be adequately catered for.

2. **Accidents**: All floor surfaces, ramps and stair tread shall be of rough surfaces to ensure adequate sole grip and reduce the tendency of toppling over. Also, ramp slope shall not exceed 6^{o} to the horizontal. Details shall cater for steel railings behind the glass curtain walls. All stairs and voids shall be supported by perforated steel sheet railings properly fixed to concrete beams and floors.

3. **Security:** The security of exhibits and other valuable objects is of much importance. Exhibits shall be kept in a secure store, with provision for a storage vault. This store shall

be of concrete walls; located in a restricted area of the basement floor. Also, there shall be provision of security lobbies and security checks, also a curators office shall be provided such that the entire display area is visible from within it.

Double security doors shall be provided at all points of importance. Also the provision of closed-circuit cameras shall be carefully schemed during design by a services consultant, carefully integrated with the alarm system. Dead and unlit spaces shall be minimized to a bearable minimum. The plan concept allows for continuous flow from space to space.

4. **Structural safety:** All issues regarding structural safety (including serviceability) shall be resolved in consultation with a structural engineer.

6.2.5 6.10 COLOUR AND TEXTURE CONTROL.

Colours shall be used to create a variety of moods and experiences. It can have a profound effect on how we feel both mentally and physically (Nicholson, 2002).

Colours, if properly used with lighting conditions can result in various perceptions. The following colour scheme shall be adapted for interior spaces:

i. **Analogous shades**; shall be alternated and adapted for all lounges to complement the water bodies and interior plant. This shall result in serene and peaceful environments within chaotic interior spaces; such as the main atrium shaft.

ii. **Complementary and triadic colours**; shall be used to energize spaces, that encourage participatory activities. They include bright red, yellow and deep blue; to be used in rhythmic patterns to create vivid and lively effects. They shall also used to draw attention to objects such as freestanding walls, columns, beams and railings.

iii. **Monochromatic colours;** are all the lines of a single colour. This allows for moderation of the energy of bright colours. They shall be used to create subtle and peaceful effects,

even though extreme use can create boring and dulling effects. These shall be used to moderate triadic colours; especially around edges, alternate faces and the general ambience of spaces where these triadic colours are found.

iv. **Warm and cool colours;** such as orange, yellow and other valid and soothing natural colours. Proper use can create a variety of effects.

v. **Colours that move;** colours can appear to move within spaces. For example, bright, high-intensity, warm colours advance in space. (Nicholson, 2002). Warm colours appear to come towards you, while cool colours appear to recede away. A proper combination of such colours shall be applied to circulation spaces, so as to encourage movement. Also, the application of these colours can help to create an appearance of depth or distance.

Texture variation shall be applied through choice of materials. Rough surfaces shall be applied to all surfaces along circulation paths for two reasons. They are:

i. To reduce the maintenance cost of everyday use

ii. To create uncomfortable feelings, so that users are encouraged to keep moving, rather than clogging within such spaces.

Smooth and slightly reflective surfaces shall be applied on exhibition walls to encourage illumination within space

CHAPTER SEVEN

DESIGN REPORT

7.1 SITE CONCEPT

The function and personality of a building should be well reflected visually and psychologically. This visual unity should be well understandable to the human eye and the animate community.

The site concept for the proposed Art centre is based on:

(a) Accessibility.

(b) Provision of vehicular traffic free areas that are pedestrian intra-centre traffic devoid of cross-vehicular traffic. This will help in maintaining acceptable noise level required for effective work particularly the exhibition halls.

(c) Zoning and positioning of buildings

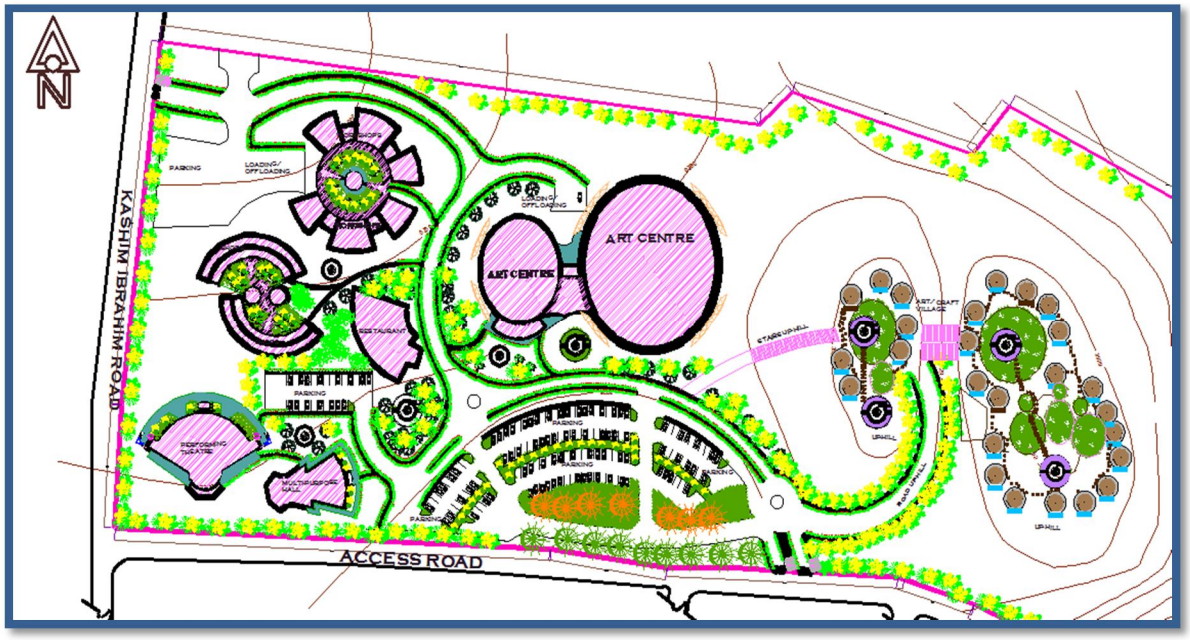


Fig 7.1; showing organization of buildings on site
Source; Researcher (2012)

7.2 DESIGN CONCEPT

The design concept is derived from the form of a gourd. The gourd is a hard-rinded inedible fruits of the plants of the two Cucurbitaceae genera Lagenaria and Cucurbita and to their dried fruit shells, often used for ornament, instruments, utensils and vessels.



Plate 7.1; showing a decorated gourd
Source; Researcher (2012)



Plate 7.2; showing a decorated gourd
Source; Researcher (2012)

The hard-rinded fruits can have carving done to create scenes raised in relief. Painting and wood burning are also used to decorate the shells. For the purpose of this research, the Mexican bottle gourd will be used as a form concept.

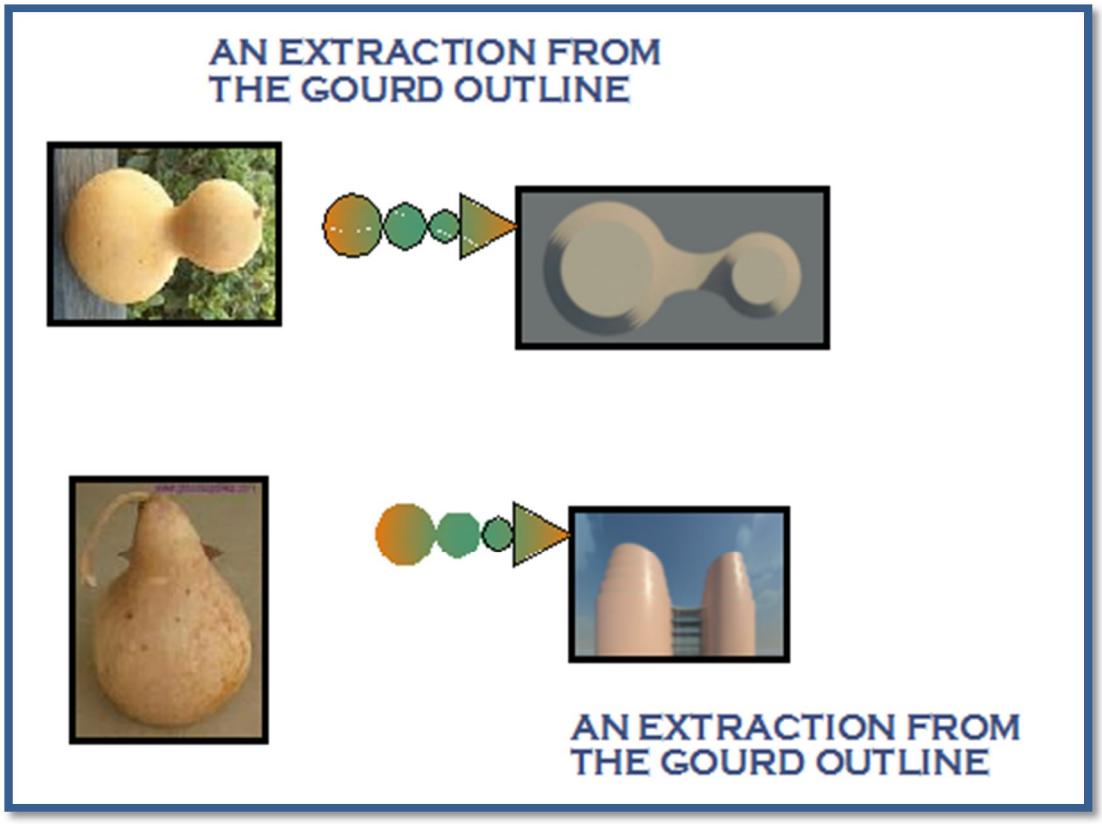


Fig 7.2; concept formulation
Source; Researcher (2012)

7.3 BUILDING FORM AND OPENINGS

The building consists of circular forms with recessed areas and a central atrium. The vertical and horizontal recesses provided more surface area for glazing and made the building self-shading.

There are two types of openings in buildings; vertical openings and horizontal openings. Both types were used in the building design.

i. Vertical openings.

The distance that natural light can penetrate into a building via a vertical opening is dependent on the height of the opening in relation to the height of the room. Thus windows made of laminated glass in the form of glazing are provided. In addition to the windows, light shelves on d top of each window opening is provided to serve as a daylighting strategy but also to support *'stack effect'*.

ii. Horizontal openings.

Horizontal openings are also known as roof or sky lights. For the purpose of this research, the dome (atrium) skylight was chosen to light the core of the main building complex. Tubular skylights also known as light tubes are used to provide light for all spaces.

7.4 BUILDING MATERIALS

1. ETFE material

ETFE foil also known as Ethylene Tetra Flouro Ethylene is a very transparent material and transmits light across the entire visible light region (380-780m). A single layer of medium weight ETFE has an approximate 85% light transmission, although multiple layers will lead to only a small reduction.



Plate 7.3; Atrium made of ETFE

Source; Researcher (2012)

2. Coloured laminated glass

Laminated glass is composed of two or more layers of glass with one or more layers of a transparent/ pigmented and specially treated plastic Polyvinyl Butyral [PVB] sandwiched between the glass layers.

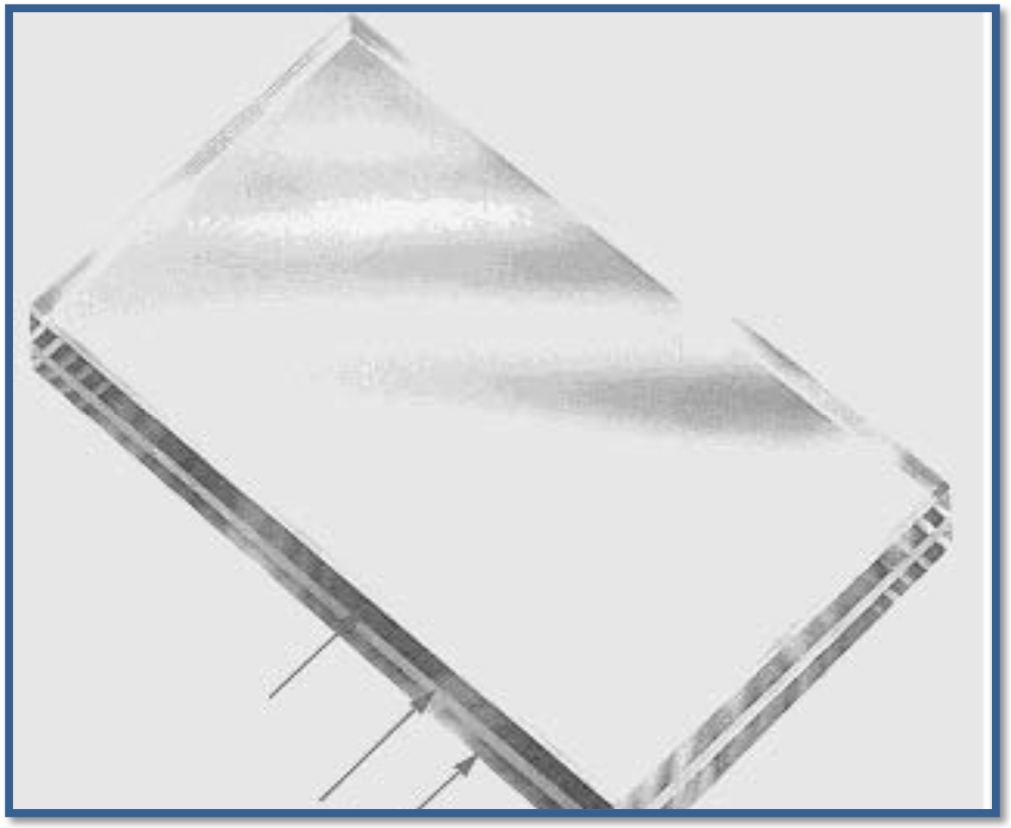


Plate 7.4; laminated glass
Source; (Garg, 2007)

7.5 SCHEDULE OF ACCOMMODATION

Table 7.1: Schedule of accommodation
Source: Researcher (2011)

ADMINISTRATION UNIT			
DESCRIPTION	NUMBER	AREA (m²)	TOTAL (m²)
- Entrance porch	1	109	109

- Reception	1	169	169
- Orientation room	2	132	264
- Permanent exhibition space	1	339	339
- Gift shop	1	35	35
- Store	1	47	47
- Janitor	1	13	13
- Toilets	10	2	20
- staircase	1	33	33
- ticket room	2	6	12
- Staff lounge	1	109	109
- Reception	1	169	169
- General Manager's office with toilet.	1	47	47
- Board room	1	98	98
- Offices	9	26	234
- Tea/ snacks room	1	49	49
- Store	1	47	47
- Janitor	1	13	13

MAIN BUILDING			
DESCRIPTION	NUMBER	AREA (m²)	TOTAL (m²)
GROUND FLOOR			
- Art storage	1	710	710
- Art preservation and conservation	1	710	710
- Library	1	710	710
- Resource centre/cafe	1	710	710
- Store	1	14	14
- Utility room	1	15	15
- Toilet	6	2	12
FIRST FLOOR			
- Museum	1	1405	1405
- curator	1	32	32
- photography and graphics	1	374	374
- preparation room	1	84	84
- darkroom	1	30	30
- Store	1	14	14
- Utility room	1	15	15
- Toilet	6	2	12
SECOND FLOOR			
- Temporary exhibition	1	1388	1388
- Curator	1	47	47
- Store	1	14	14

- Utility room	1	15	15
- Toilet	6	2	12
THIRD FLOOR			
- Temporary exhibition	2	1378	1378
- Curator	2	32	64
- Store	1	14	14
- Utility room	1	15	15
- Toilet	6	2	12
FOURTH FLOOR			
- Temporary exhibition	1	1370	1370
- Permanent exhibition	1	685	685
- Curator	1	32	32
- Auction room	1	685	685
- Store	1	14	14
- Utility room	1	15	15
- Toilet	6	2	12
FIFTH FLOOR			
- Painting studio	1	679	679
- Children studio	1	679	679
- Architectural studio	1	679	679
- General studio	1	679	679
- Store	1	14	14
- Utility room	1	15	15
- Toilet	6	2	12

PERFORMANCE THEATRE			
DESCRIPTION	NUMBER	AREA (m²)	TOTAL (m²)
- Auditorium	1	1.1m² per person	898
- Stage	1	83	83
- Back stage	1	34	34
- Changing rooms	2	15	30
- Light control rooms	2	10	20
- Curtain room	1	46	46
- Toilets	14	2	28
- Entrance and ticket	3	16	48
- Security points	4	54	216
- Snacks and drinks	1	16	16
- Pop corn points	1	16	16

MULTIPURPOSE HALL			
DESCRIPTION	NUMBER	AREA (m²)	TOTAL (m²)
- Hall	1.1m² per person	367	367
- Changing rooms	2	15	30
- Backstage	1	73	73
- Stage	1	75	75
- Toilets	4	2	8

WORKSHOPS			
DESCRIPTION	NUMBER	AREA (m²)	TOTAL (m²)
- Sculpture	1	189	189
- Wood work	1	189	189
- Pottery	1	189	189
- Metal work	1	189	189
- Fabrics, weaving and leather	1	189	189
- Textile	1	189	189
- Store	4	23	94
- Toilets	12	2	24
- Changing rooms	4	14	56

RESTAURANT			
DESCRIPTION	NUMBER	AREA (m²)	TOTAL (m²)
- Dining room	1	539	539
- Kitchen	1	99	99
- Waiter's walkway	1	15	15
- Dry store	1	17	17
- Cold store	1	18	18
- Toilet	4	2	8

RETAIL SHOPS

DESCRIPTION	NUMBER	AREA (m²)	TOTAL (m²)
- Shops	22	21	462
- Toilets	4	2	8

7.6 THE FLOOR PLANS

The floor plan includes the main building complex, the theatre, multipurpose hall, workshops, shops and restaurant.

i. Main building complex

This is the building that contains the administrative unit containing offices, exhibition halls, museum, library, storage spaces, auction room, boardroom, studios, resource centre and internet cafe. A janitor room is also provided on each floor for the cleaning of the building with a utility room where all piping is done.

The internal circulation space makes transition from one floor to another easily. Transportation from floor to floor has been made easy by the provision of elevators, escalators, staircase and a ramp especially for the physically impaired persons.

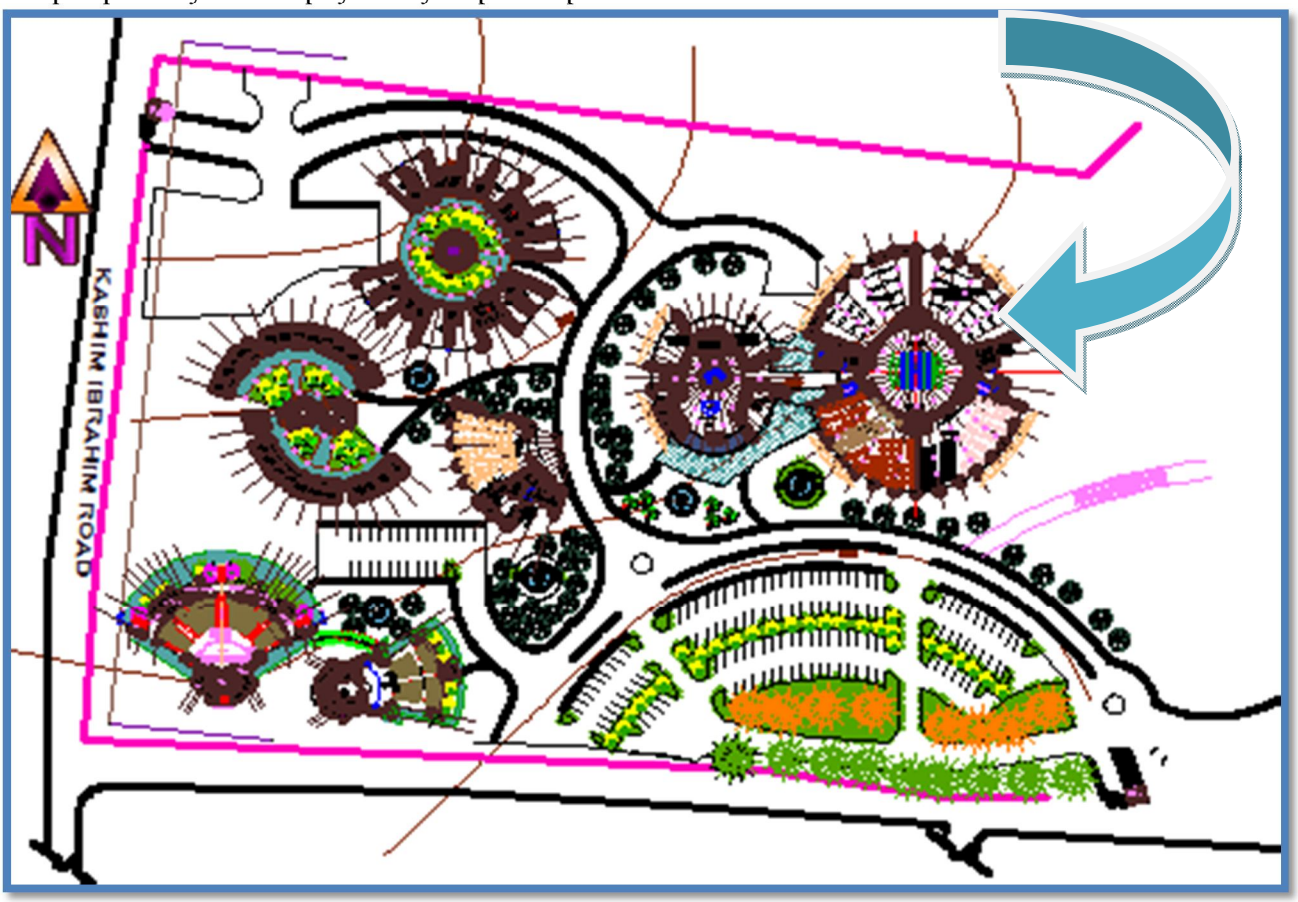


Fig 7.3; Site plan showing the main building
Source; Researcher, (2012)

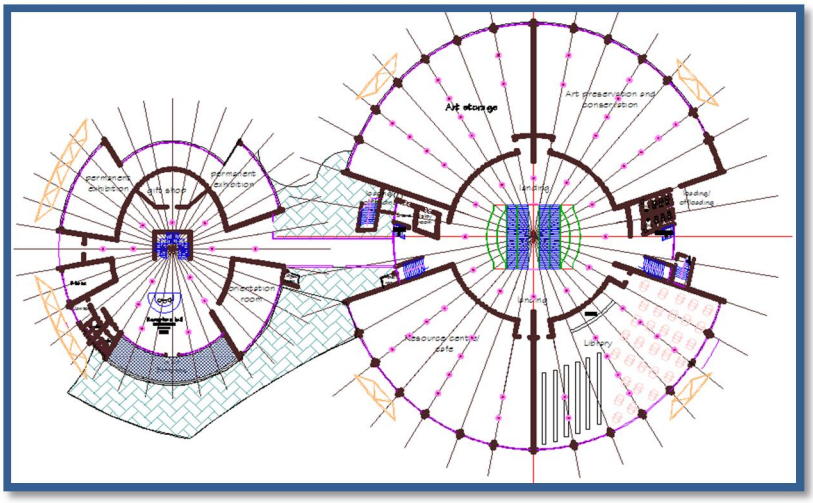


Fig 7.4; Ground floor plan of the main building
Source; Researcher, (2012)

The ground floor has two entrances, one leads to the administrative unit and the other leads to the exhibition spaces.

ii. Theatre

The theatre is located at the south-western region of the site. This is located away from the main building containing the exhibition halls because of noise that will affect concentration in the exhibition halls. The theatre has three vomitories whereby the performers however have the benefits of accessing the stage via the vomitories. This makes the theatre more interactive and intimate during plays. The design also affords natural ventilation from the rear of the auditorium. Clerestory windows are included also for stack effect ventilation. A plenum chamber lies beneath the hall for HVAC installations. The walls of the hall are finished with diffractive wood for good acoustics. The theatre contains two changing rooms, four water closets, two light control rooms, a back stage and curtain room. Attached also are ticket rooms, snacks and popcorn shops, toilets for audience and security points and has the capacity to accommodate 1050 persons.



Fig 7.5; Site plan showing the theatre
Source; Researcher, (2012)

iii. Multipurpose hall

The multipurpose hall is located at the south-western region of the site. The multipurpose hall has been designed to be adequate for adaptive use of the hall. The seating shall be bleacher seating. Thus the hall can be converted into a clear empty floor depending on intended use. The multipurpose hall has a stage, a backstage, two light control rooms, two changing rooms and four toilets.

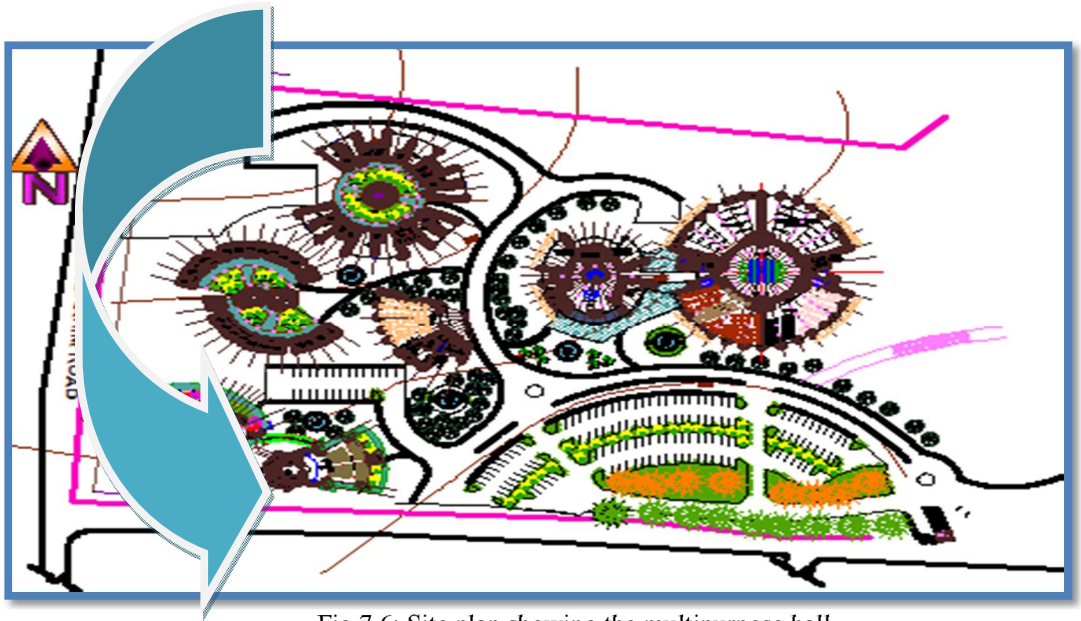


Fig 7.6; Site plan showing the multipurpose hall
Source; Researcher, (2012)

iv. Art and craft workshops

The art workshops are located at the north-western region of the site. They are located a bit away from the main building complex because of noise but close enough to be able to easily transport art works to it and into the exhibition spaces. A link road is created for the purpose. The workshop is also located beside the other entrance to the site which is meant for goods and services. Provision for loading and offloading points of raw materials and finished products were made. The workshop has attached to them, toilets with changing rooms and stores, and is designed in a courtyard format.

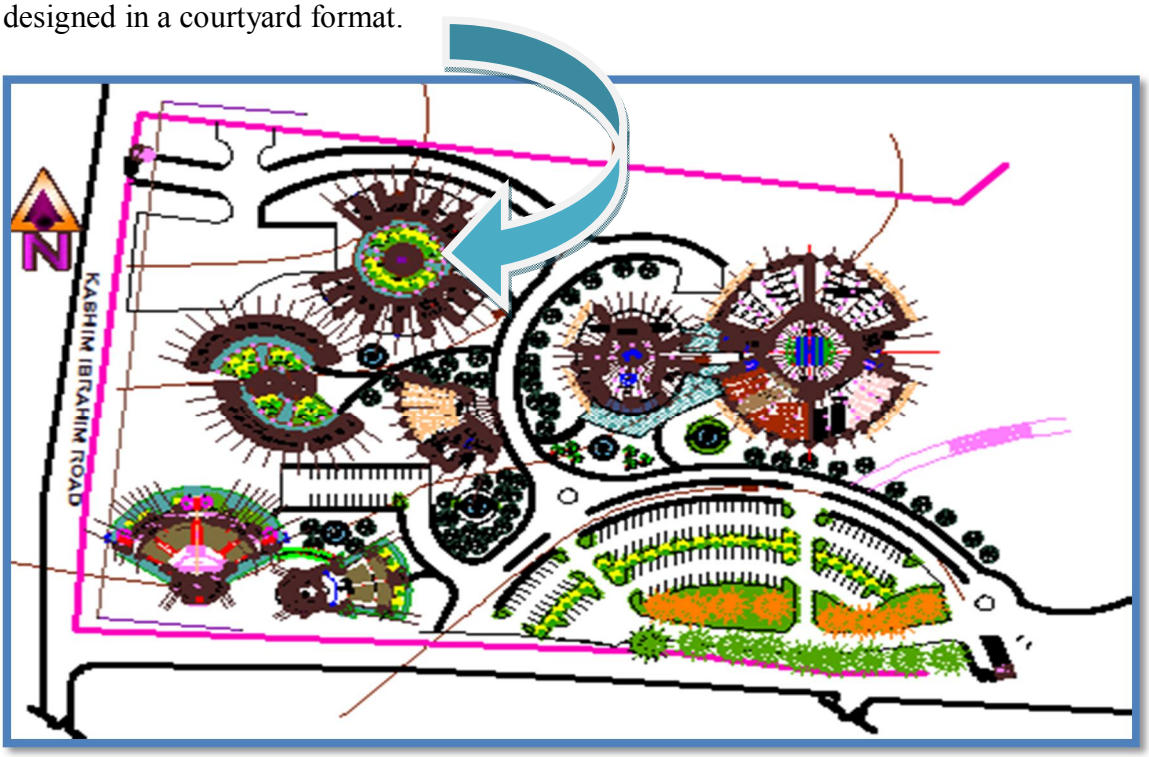


Fig 7.7; Site plan showing the art and craft workshops
Source; Researcher, (2012)

v. Restaurant

The restaurant is delibrately located so that all the other buildings surrounds it. This is so for easy accessibility from all sides. The raestaurant has a dining space for 176 persons per time.

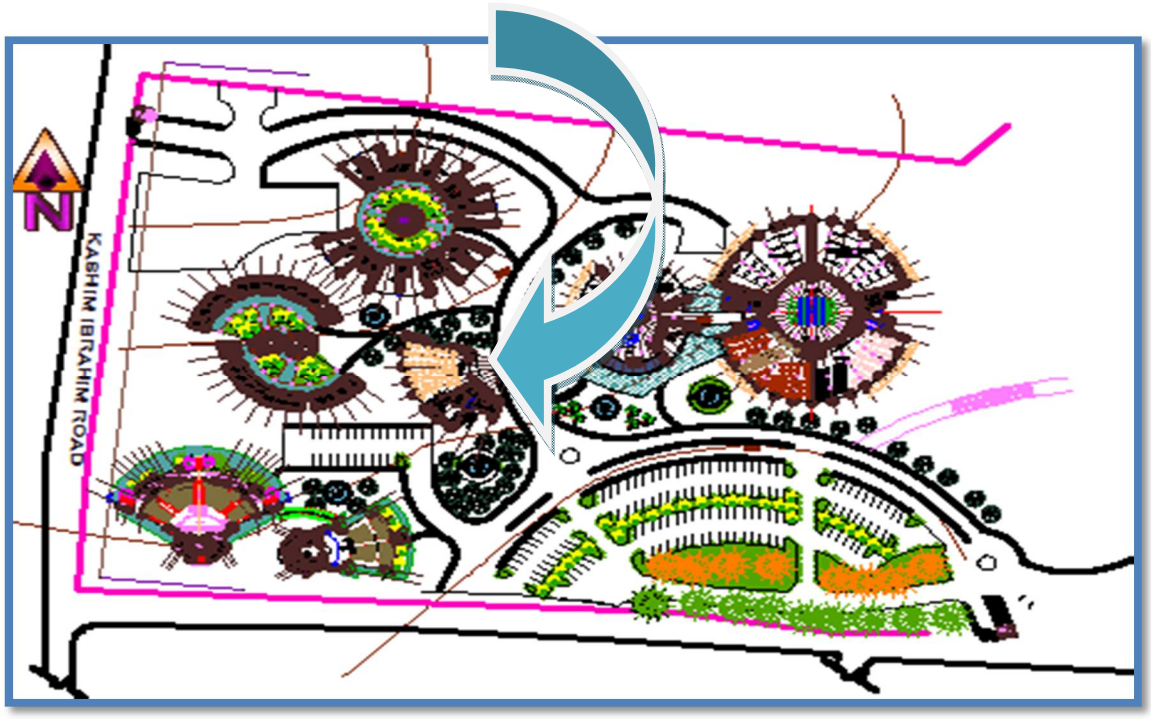


Fig 7.8; Site plan showing the restaurant
Source; Researcher, (2012)

vi. Retail shops

The shops will be used for sales of artistic works and stationeries to visitors. It is located beside the workshops for easy transportation of works to the shops. The design of retail shops adopts the shape of two semi-circles facing each other. It has attached to it toilets and stores.

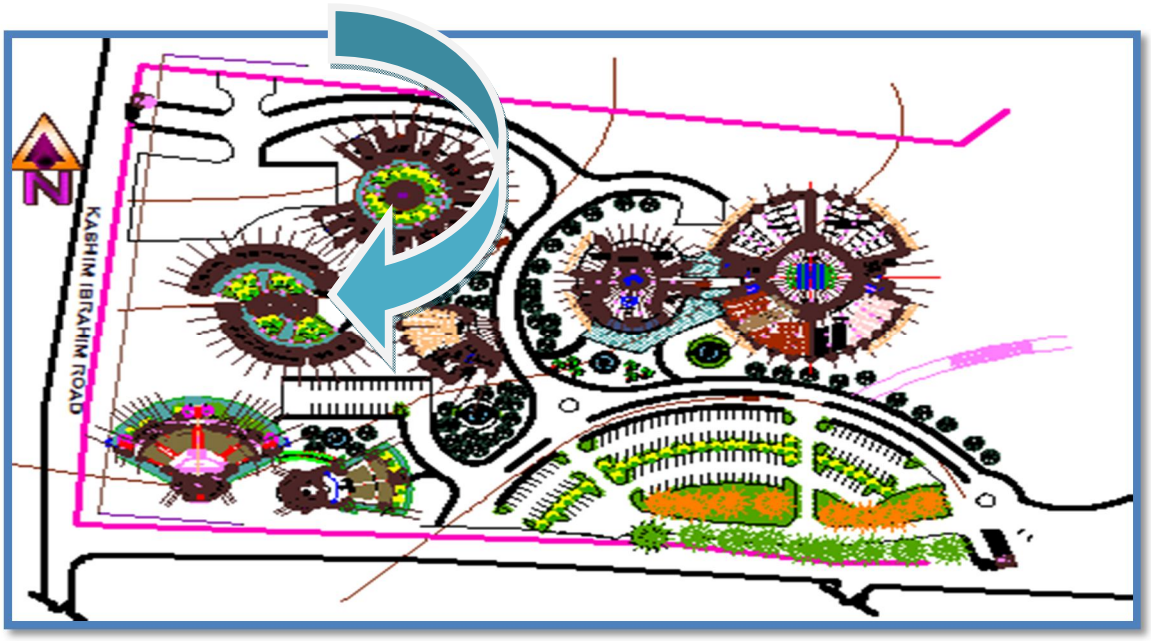


Fig 7.9; Site plan showing the retail shops
Source; Researcher, (2012)

vii. Art village

The art village is located on the hill located on the site. This is represented by series of round open huts or gazebos. This provides avenue for interaction among youths.

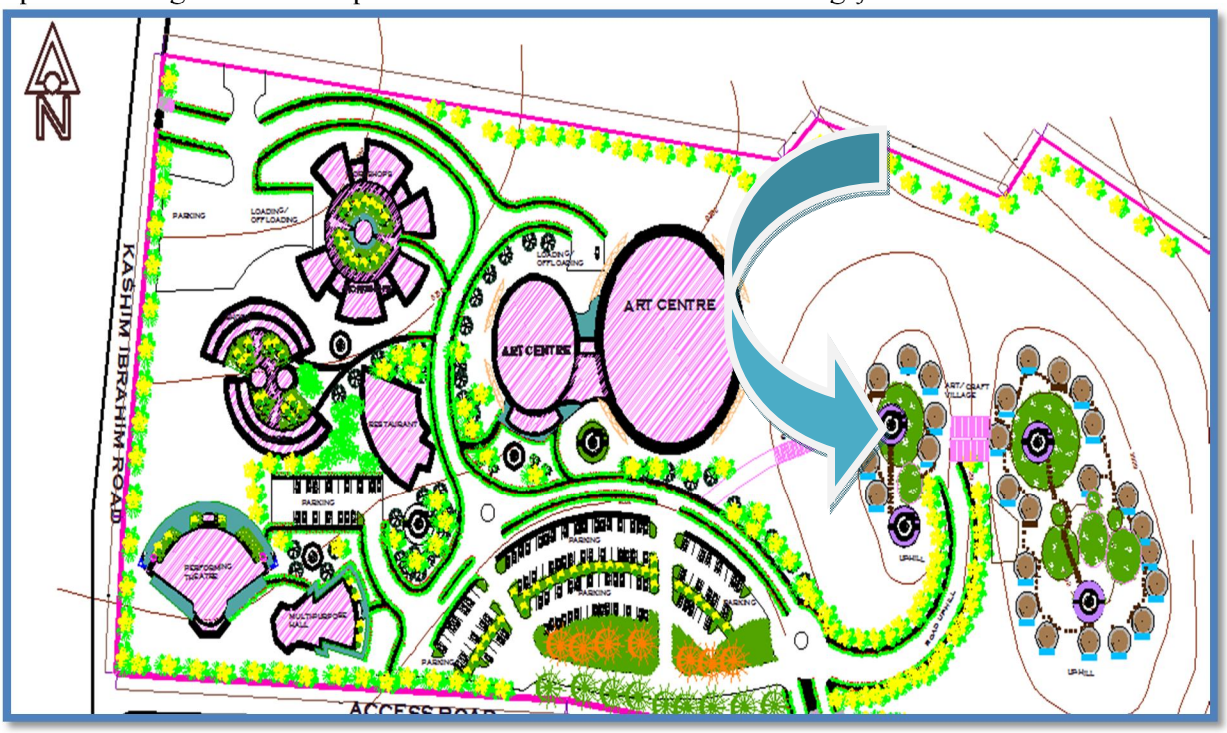


Fig 7.10; Site plan showing the art village
Source; Researcher, (2012)

7.7 ELEVATIONS

The elevations show the general outlook of the art centre which are viewed from the north view, south view, east view and west view. Daylighting systems used for this research are seen on the elevations. Photovoltaic arrays are also used for harnessing solar energy to convert to electricity for lighting of the centre. These arrays used are seen on the elevations in plate 7.2. The elevations try to portray the form of the concept chosen for this project.

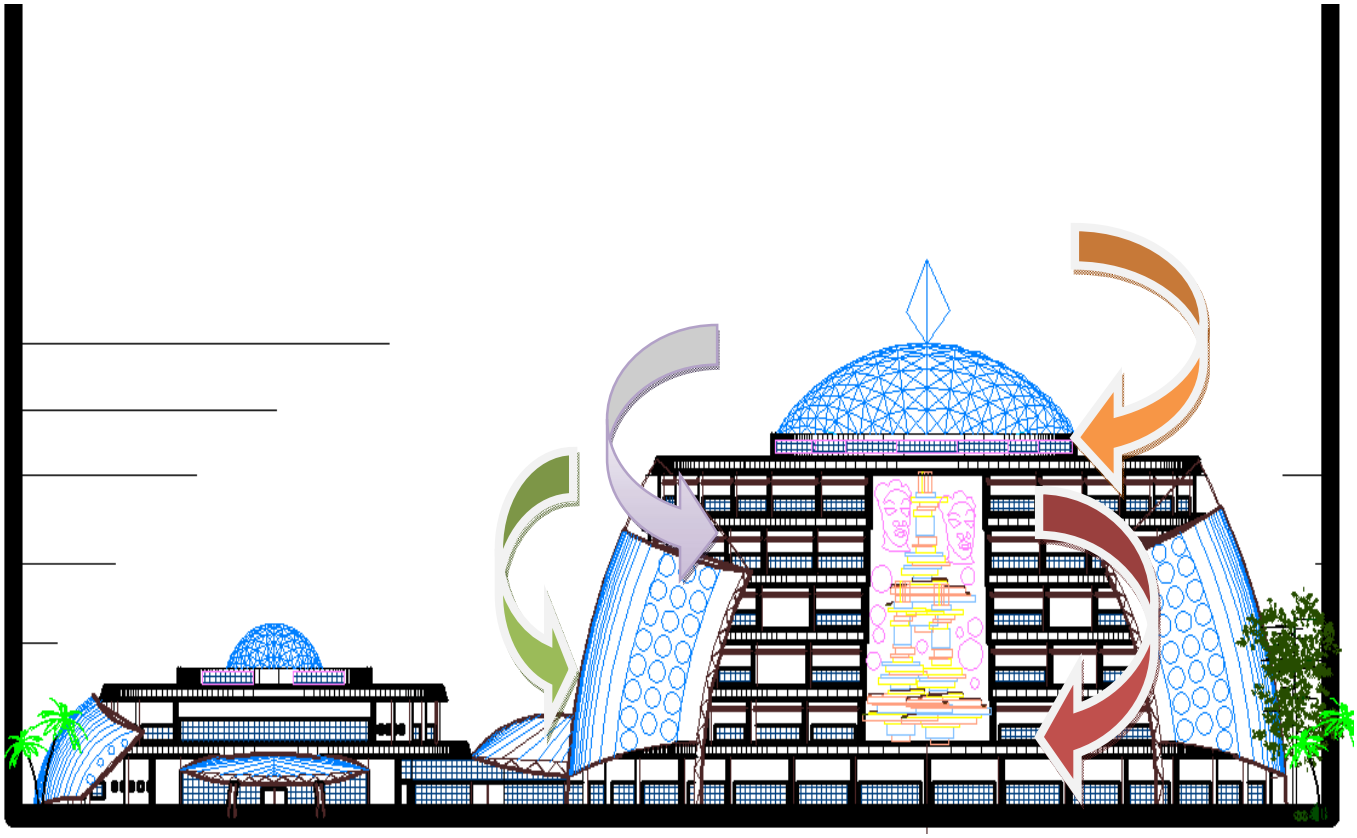


Fig 7.2; An elevation view of the centre
Source; Researcher, (2012)

7.8 DAYLIGHT ELEMENTS USED

Four types of daylighting strategies were used for this research which include;

a. Use of laminated glass for all fenestration on the building complex

b. Use of Light shelves which allows for controlled reflected light into the spaces

c. Use of tubular skylight also known as light tubes into exhibition spaces

d. Use of atrium made of ETFE (Ethylene Tetra Flouro Ethylene) material.

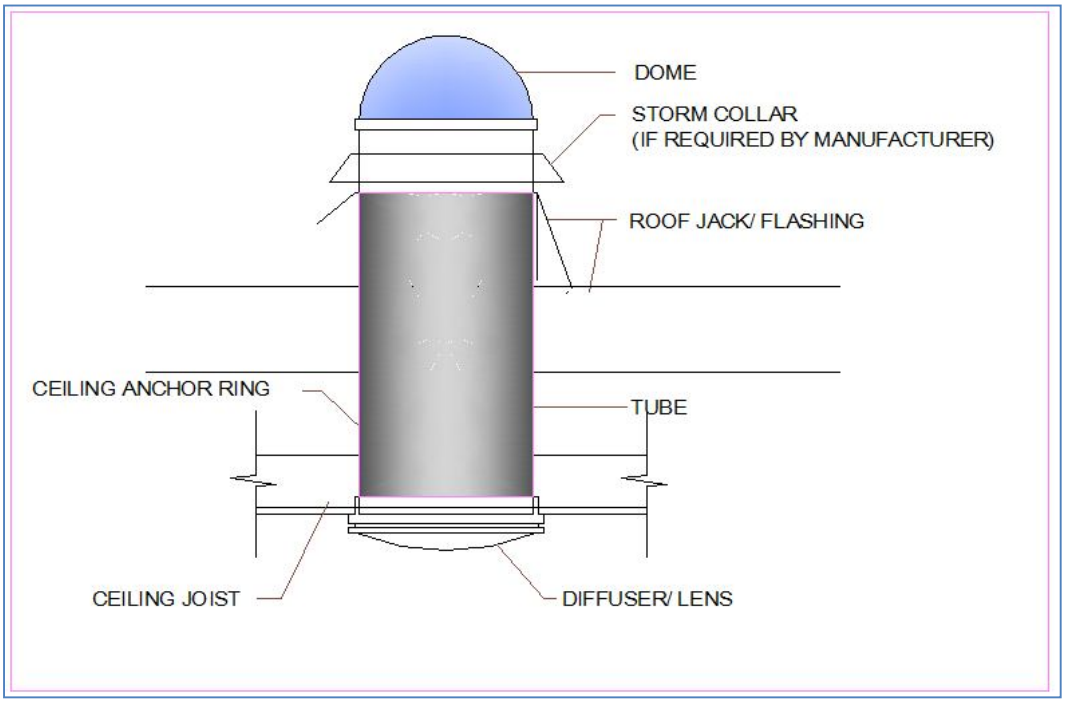


Fig 7.12; showing details of a light tube
Source; Researcher (2012)

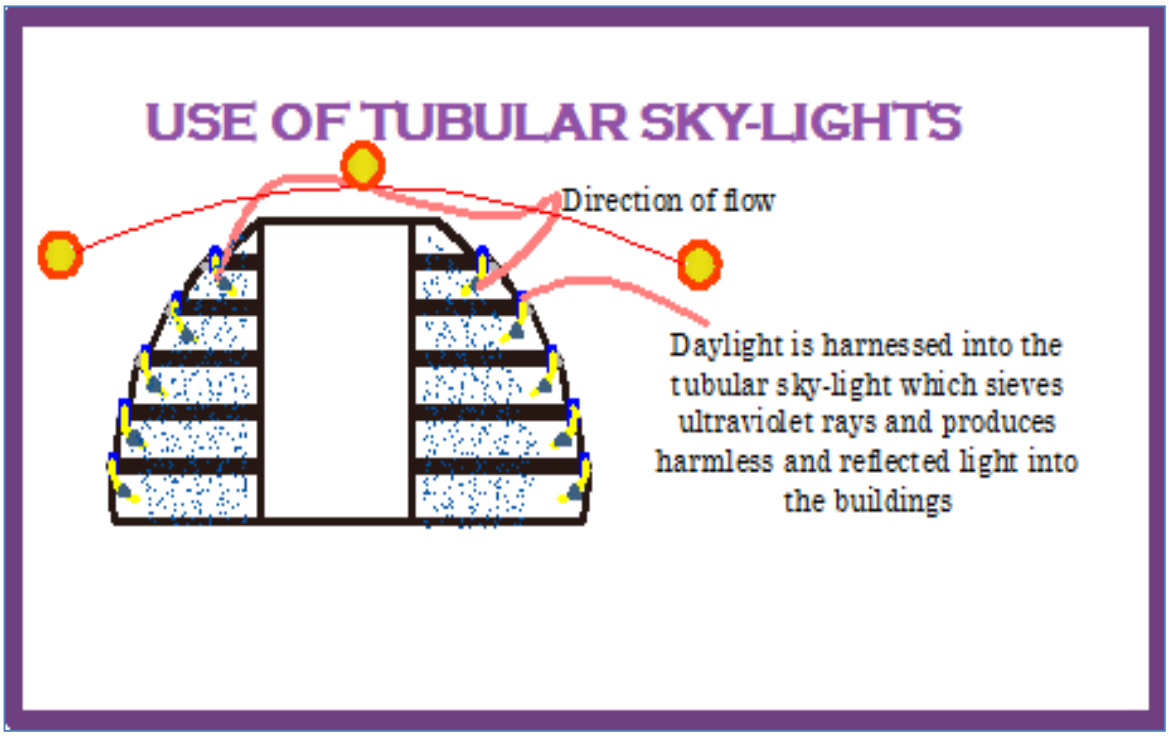


Fig 7.13; showing how light tubes are used

Source; Researcher (2012)

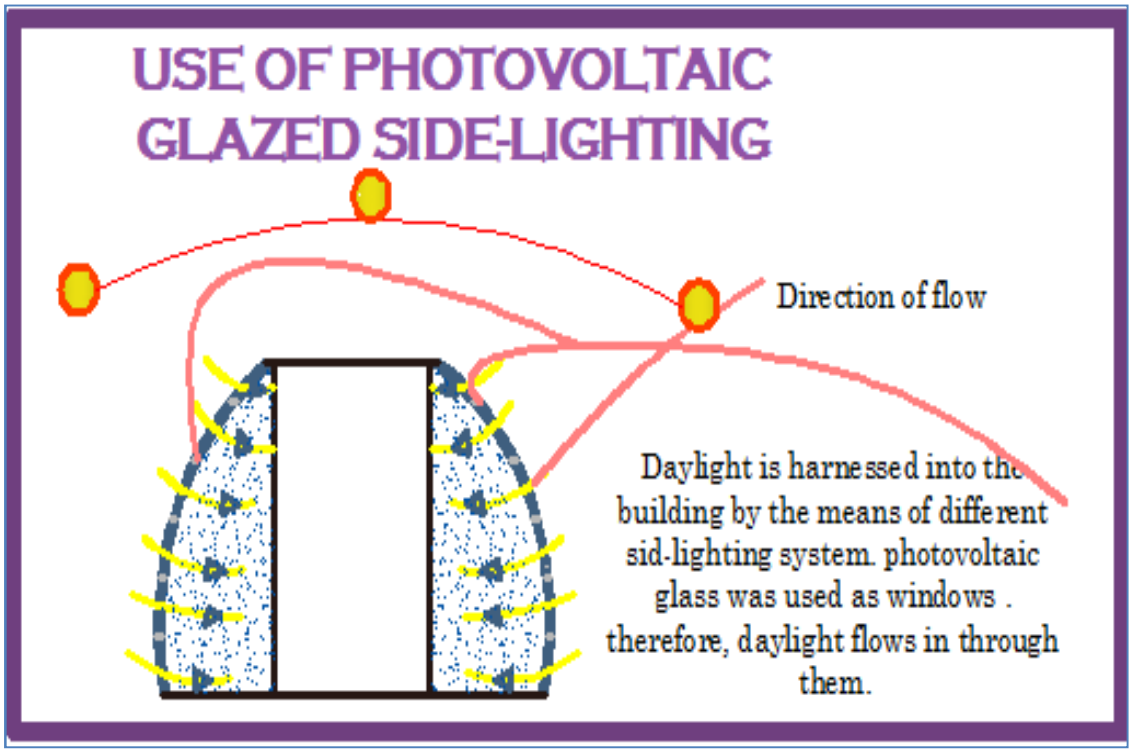


Fig 7.14; showing how light transmit through laminated glass
Source; Researcher (2012)

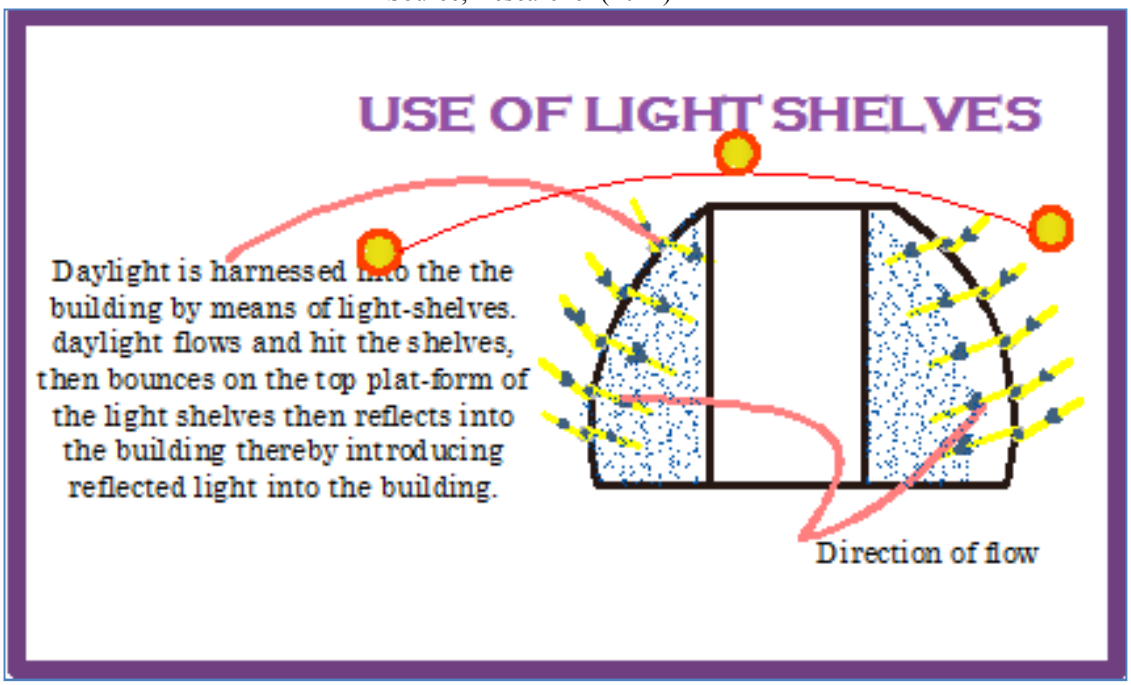


Fig 7.15; showing how light shelves are used
Source; Researcher (2012)

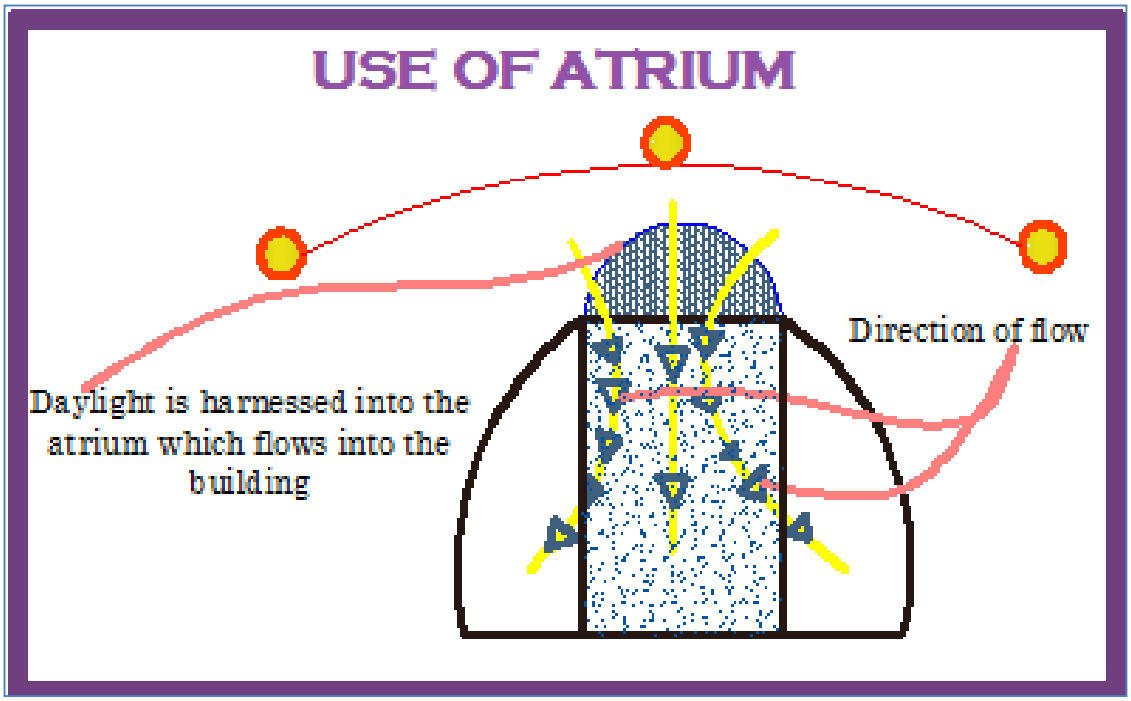


Fig 7.16; showing how the atrium is used
Source; Researcher (2012)

7.9 SERVICES

For proper up keep of the center, the following are given due consideration in the design. These include; water supply, sewage disposal, drainage system, maintenance and networking operations.

i. **Water supply:** Boreholes were proposed for the facilities whereby water is supplied into overhead tanks from where it can be distribution to various sections of the facility. The distribution channels are 5mm diameter galvanized steel.

ii. **Sewage disposal:** This is effected by piping at various points of collection, from inspection chambers to septic tanks and finally to soak away pits. The water closets of each zone or buildings are grouped to have a simple site sewage disposal system

iii. **Drainage system:** Drainage of all storm and waste water is achieved by gravity. The site slopes downward towards the south-western flank of the site. Concrete drain pipes of 250mm in diameter is provided alongside inspection chambers are located at convenient intervals for easy blockage clearance.

iv. **Maintenance:** It is recommended that regular maintenance works be carried to ensure that the expected lifespan of the building is reached. Maintenance facilities are provided for the use of the entire facilities.

v. **Parking and walkways:** A total of 167 parking spaces is provided for user. All parking spaces are fully tarred and landscaped for easy definition. All the walkways on the site are open and finished with paving stones

vi. **Fire precaution:** In order to prevent fire hazards, fire safety regulations are adhered to. The risk of fire outbreak is categorized thus: risk to life, risk to structure or building and risk to property or contents in the building. Fire safety measures took are;

   a. Adequate means of escape were provided by providing escape stairs in the form of external staircase. Exit doors are provided at strategic points.
   b. Fire producing functions like the restaurant kitchen has been zoned away from the main building and other building.
   c. Provision of fire fighting agents such as fire extinguishers, hose reels and sprinkler systems are installed on all floors where they can be easy to access.

vii. **Site planning and landscape:** Adequate care has been taken to ensure ease of access to functions with the highest density of users. In addition, areas that require less noise have been zoned away from potential noise sources. Criteria for zoning on the site are based on noise, access and security.

Effort was made to sensitively respond to the landscaping of the site. Proper landscaping of the site makes the environment beautiful.

7.10 DAY LIGHT SIMULATION

The simulations for the research proposal were performed with computer software known as Ecotect. Autodesk Ecotect Analysis software is a comprehensive sustainable analysis tool that delivers a wide range of simulation and analysis functionality through desktop and web-service platforms. Powerful web-based whole-building energy, water, and carbon analysis

capabilities converge with desktop tools to conduct detailed environmental simulations and visualize results.

Ecotect can be used for the various purposes;

- Generate graphical weather data
- Calculate daylight factors for any space
- Calculate other daylight values such as sky factor and vertical sky component
- Visualise the results of daylight analysis within the 3D context of any model
- Adjust the properties of surfaces and materials that affect daylight
- Export to Radiance for more detailed analysis
- Import Revit BIM models.

7.10.1 GRAPHICAL WEATHER DATA OF JOS, PLATEAU STATE

As seen in plate 7.17 below, the various weather data of Jos is represented graphically, showing the variation in data throughout the year. Plate 7.18 shows a more expressed form of the weather data represented graphically show the rise and fall of each data of temperature, humidity, direct solar radiation, wind speed, cloud cover and rainfall.

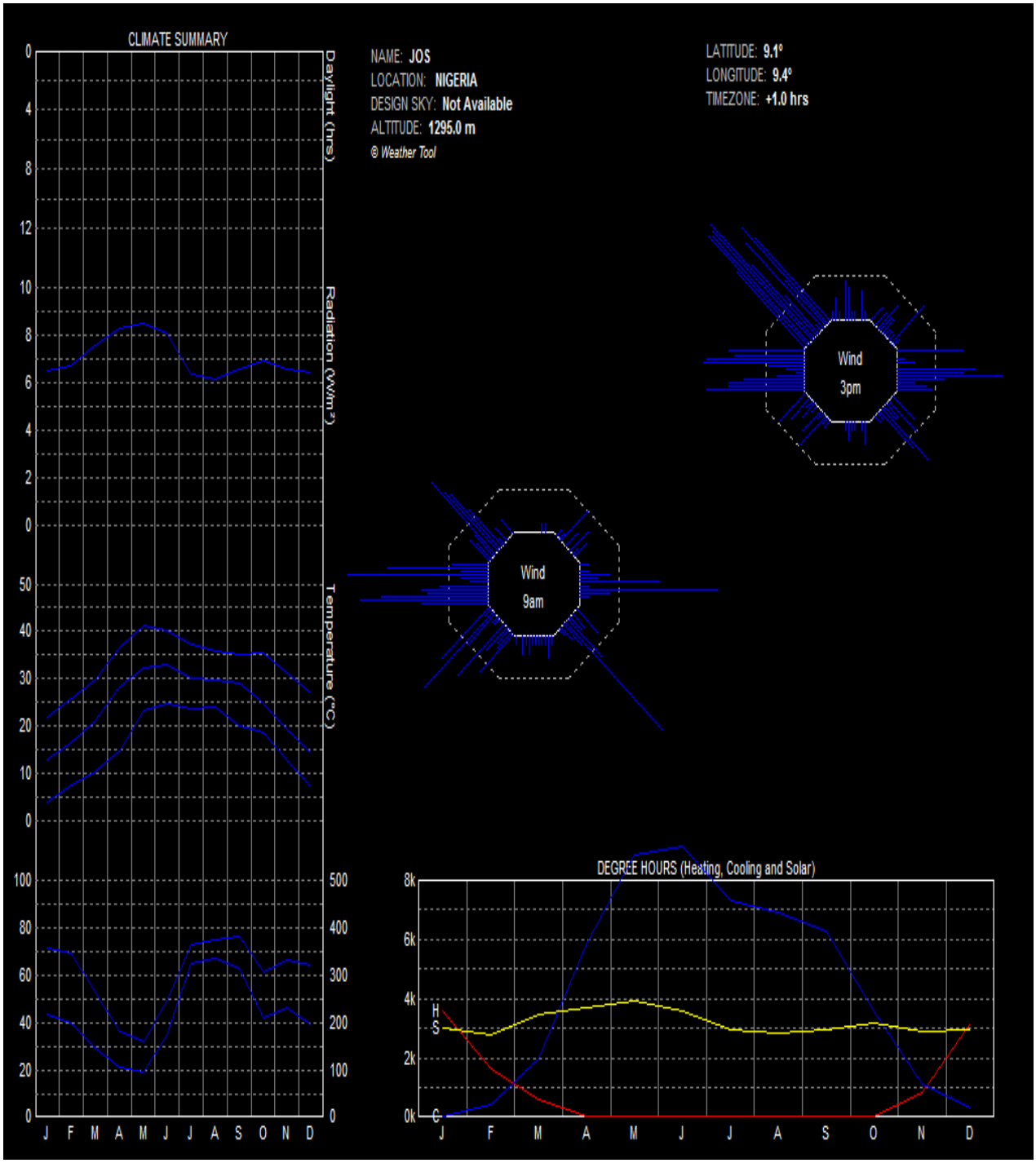


Fig 7.17; graphical weather data
Source; Researcher (2012)

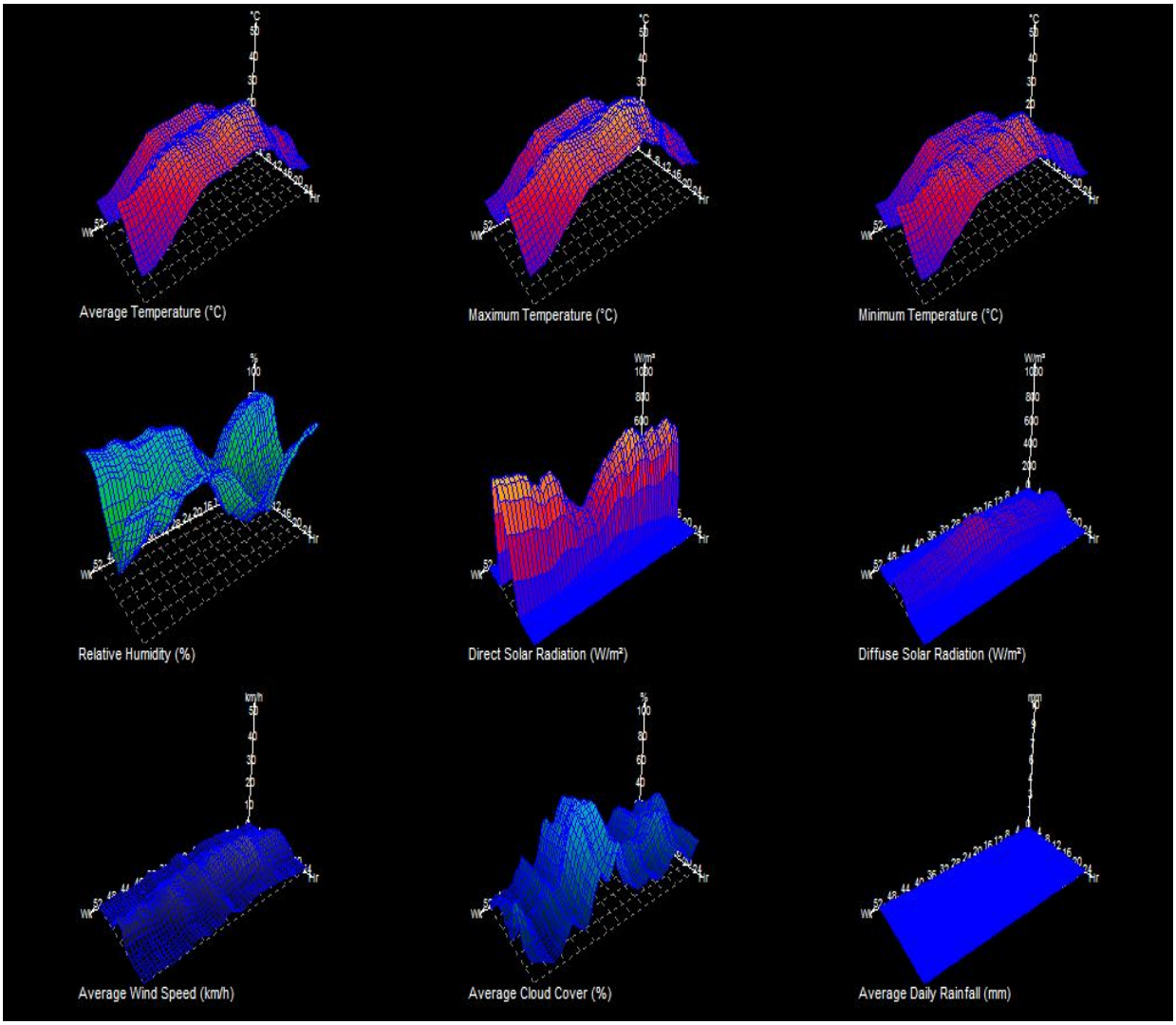


Fig 7.18; graphical weather data
Source; Researcher (2012)

7.10.2 SKY ILLUMINANCE

Sky illuminance is the total amount of light coming from the sky dome and its ability to illuminate a surface. The main determinant of overall sky illuminance is the latitude of the location. Light levels near the equator are much brighter and have a completely different quality than those at mid-latitudes and the poles. If we can take cumulative surface UV exposure as a relative indicator of daylight exposure, then Figure 7.17 below shows just how significant this variation can be over a year (Autodesk, 2008)

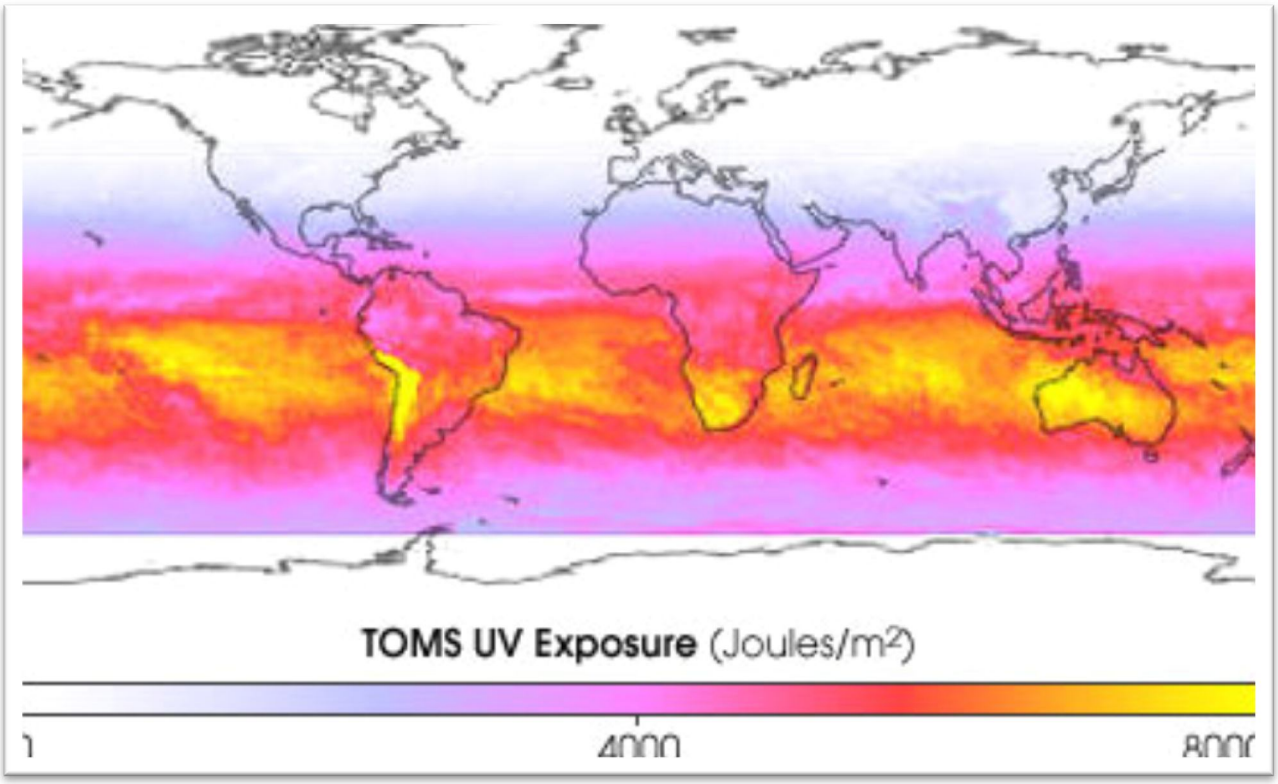


Figure 7.19: Incident UV radiation over the Earth's surface as an indicator or relative distribution of light levels.
Source: Autodesk (2008)

7.10.3 DESIGN SKY

Design Sky values are derived from a statistical analysis of dynamic outdoor sky illuminance levels. They represent the horizontal illuminance value that is exceeded 85% of the time between the hours of 9am and 5pm throughout the working year. Thus they also represent a worst-case scenario that you can design to and be sure your building will meet the desired light levels at least 85% of the time. Design sky values vary from around 12-15,000 lux at the equator down to around 3-4000 lux at latitude of ±60°, as shown in Figure 7.18 below.

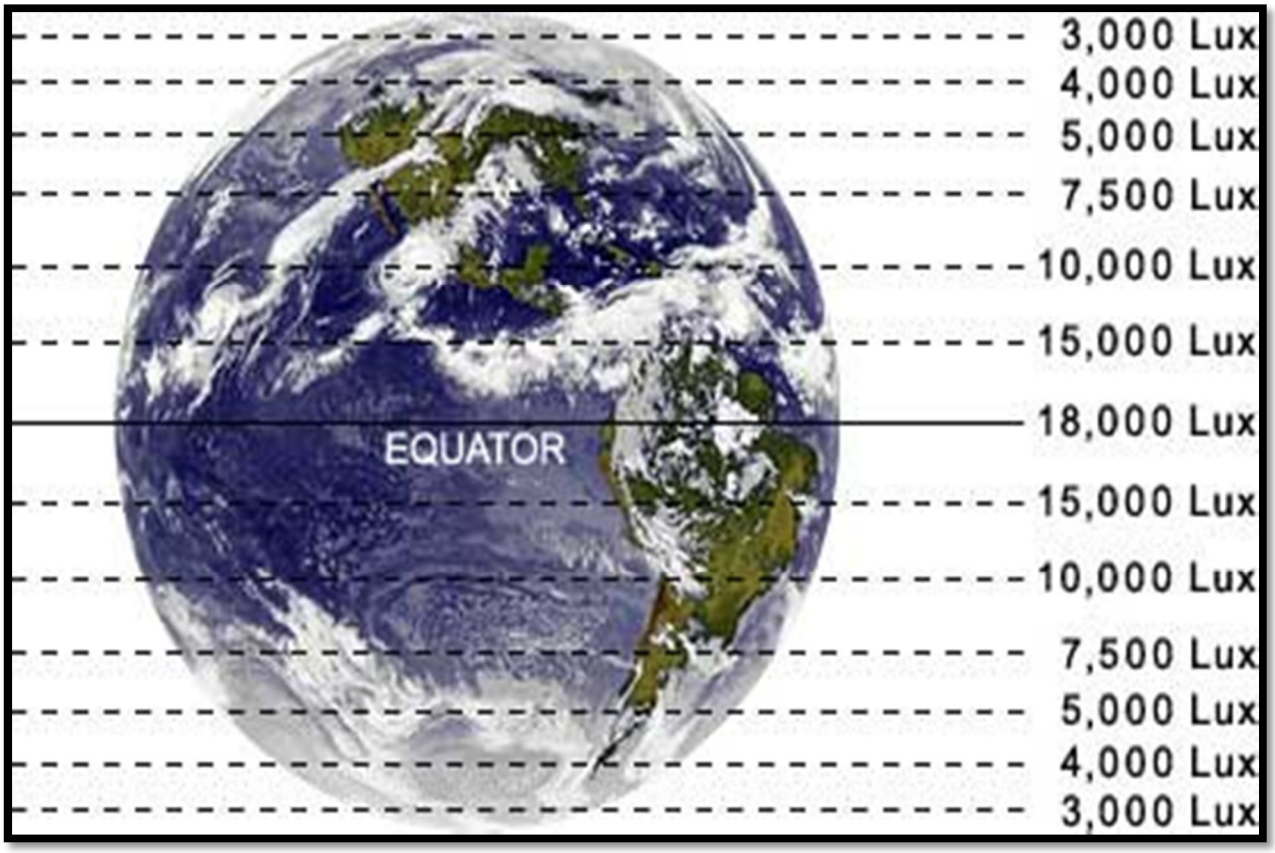


Figure 7.20: Design Sky Illuminance values are a function of latitude.

Source: Autodesk (2008)

7.10.4 SUN PATH DIAGRAM

This is a diagram that shows the sun path around a building. The sun path could be generated daily or annually. For the purpose of this research, the sun path was generated for a day (1st of April, 2012) at various intervals of time given that daylight varies in intensity every minute. The time observed for this data is 10AM, 12PM, 2PM AND 4PM as shown in figures 7.19, figure7.20, figure 7.21 and figure7.22 respectively. This time intervals were chosen according to the peak periods of which the museum will be busy the most. Figure 7.23 shows the annual sun path diagram for the research location.

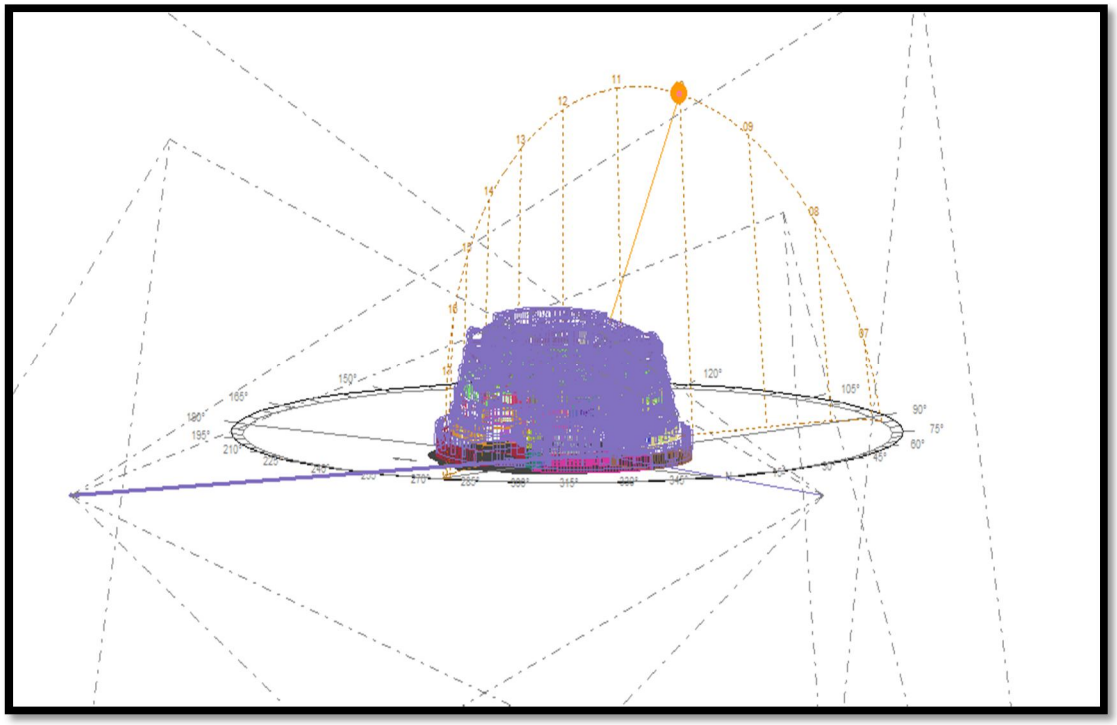


Figure 7.21: daily sun path diagram at 10AM

Source: Researcher (2012)

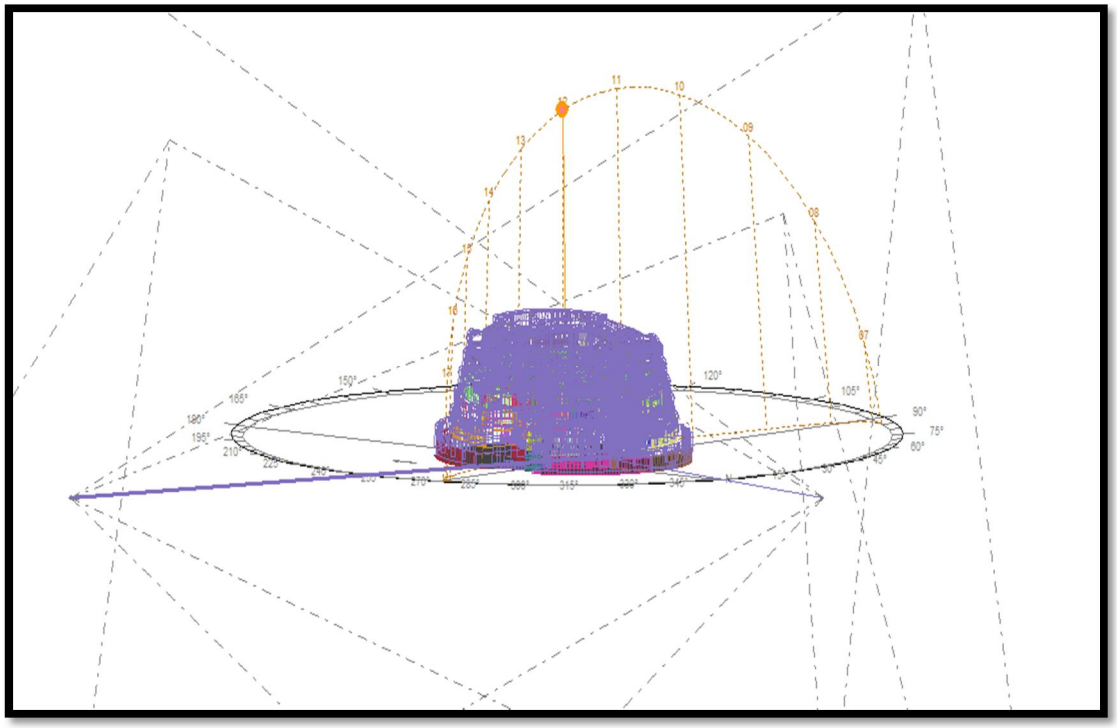


Figure 7.22: daily sun path diagram at 12PM

Source: Researcher (2012)

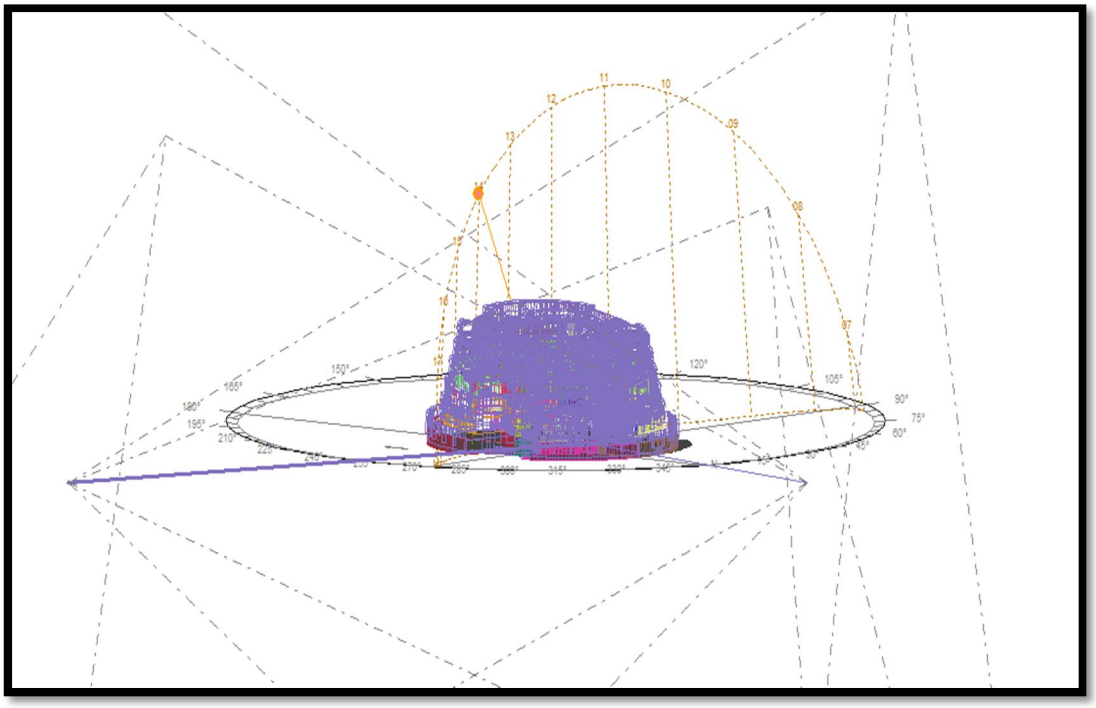


Figure 7.23: daily sun path diagram at 2PM

Source: Researcher (2012)

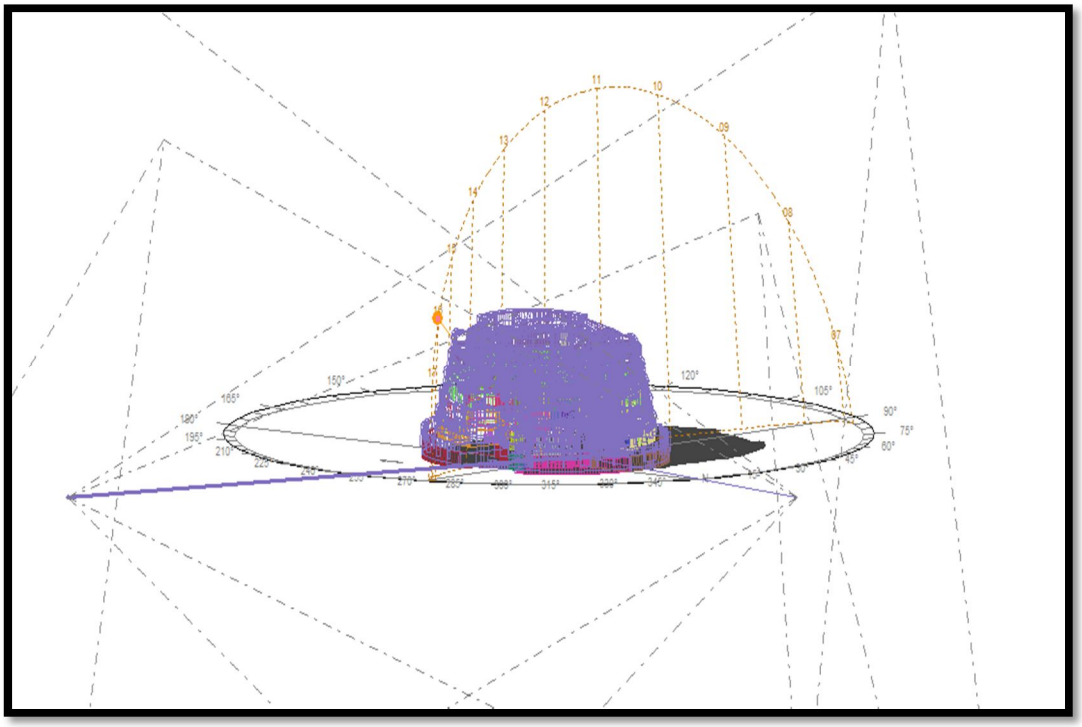


Figure 7.24: daily sun path diagram at 4PM

Source: Researcher (2012)

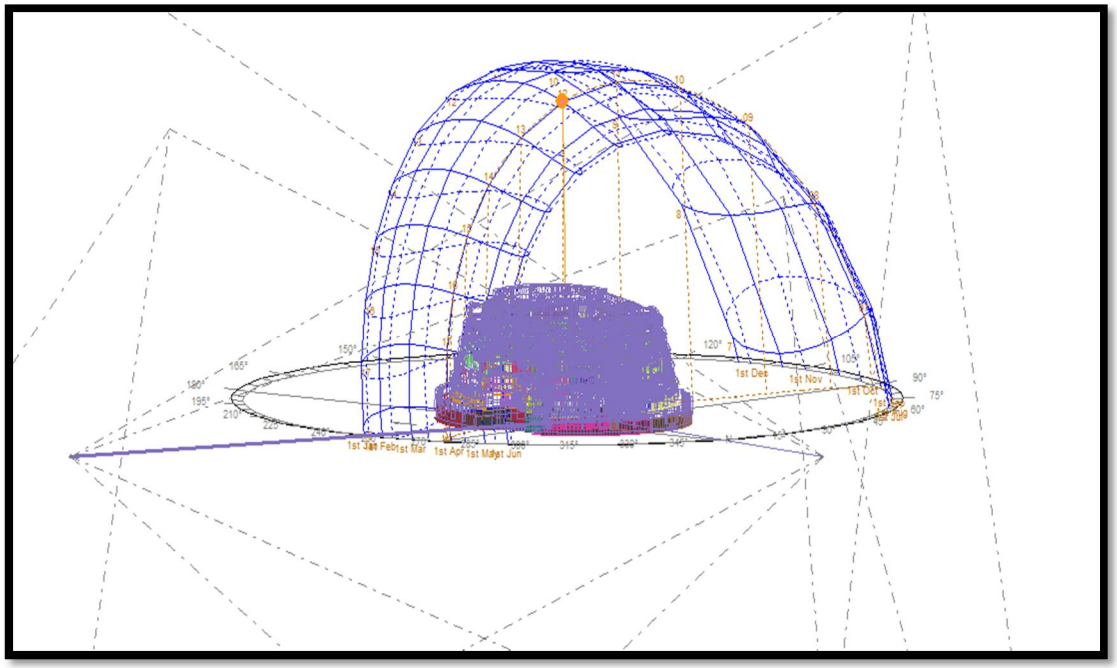


Figure 7.25: Annual sun path diagram
Source: Researcher (2012)

7.10.5 DAYLIGHT FACTOR

Daylight Factor is a measurement of the subjective quality of daylight within a room. The Daylight Factor measures the interior light levels as they compare to exterior light levels on an overcast day. For reference, a room that has a Daylight Factor of less than 2% is considered poorly lit. Rooms with Daylight Factor between 2% and 5% are considered ideal for activities that commonly occur indoors. Rooms with a Daylight Factor above 5% have strong daylighting (Autodesk, 2008).

For the purpose of the research, a sample well lit (using the various daylight strategies discussed earlier) exhibition space was put to experimental analysis, taking note the various daylight factor of the space represented in a chart. The result of the analysis and resultant chart is seen in the figures below. The value of daylight factor ranges from 1.8% – 81.8%. The sections of the room with the lesser amount of daylight factor are shaded blue and colour changes as the

intensity increases. As seen in figure 7.24, a larger percent of the space falls within 1.8% to 9.8% which makes the space ideal for exhibition.

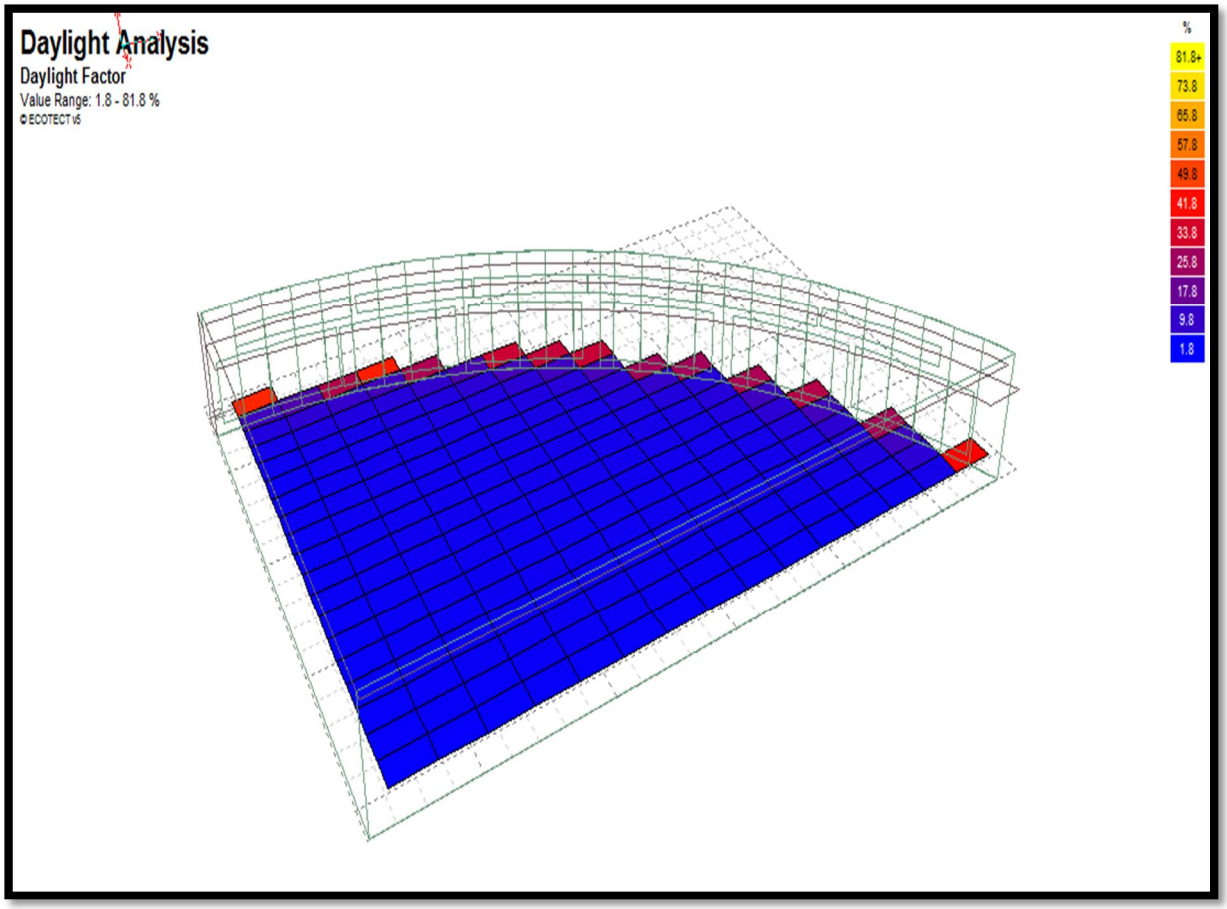


Figure 7.26: Radiance of the space
Source: Researcher (2012

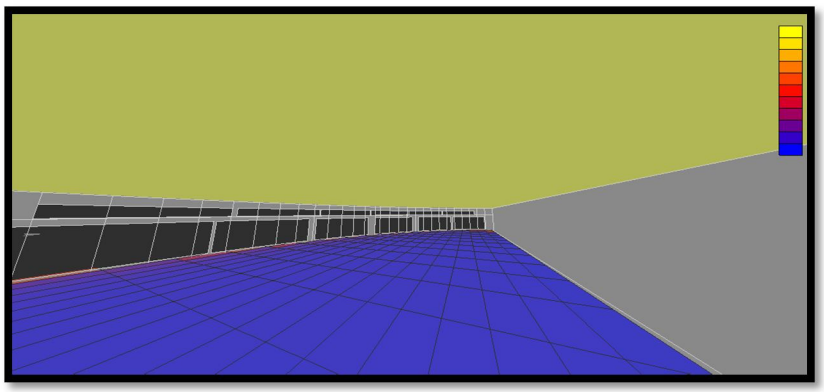


Figure 7.27: Radiance of the space in 3D
Source: Researcher (2012)

7.10.6 LIGHTING ANALYSIS

A lighting analysis can show both natural and artificial light levels at specific points in the model. This tool was used to generate the lighting analysis of the sample exhibition space so as to know the various points in which sensitive and non sensitive artworks and artifact can be placed. The sample exhibition space used above was rendered using the Radiance Software. Readings were then observed at different time interval according to the peak periods in which the museum will be used which is shown Figure 7.26, figure 7.27, and figure 7.28 respectively. It is observed that different points in the room had different readings (amount of light in lux) at different time intervals.

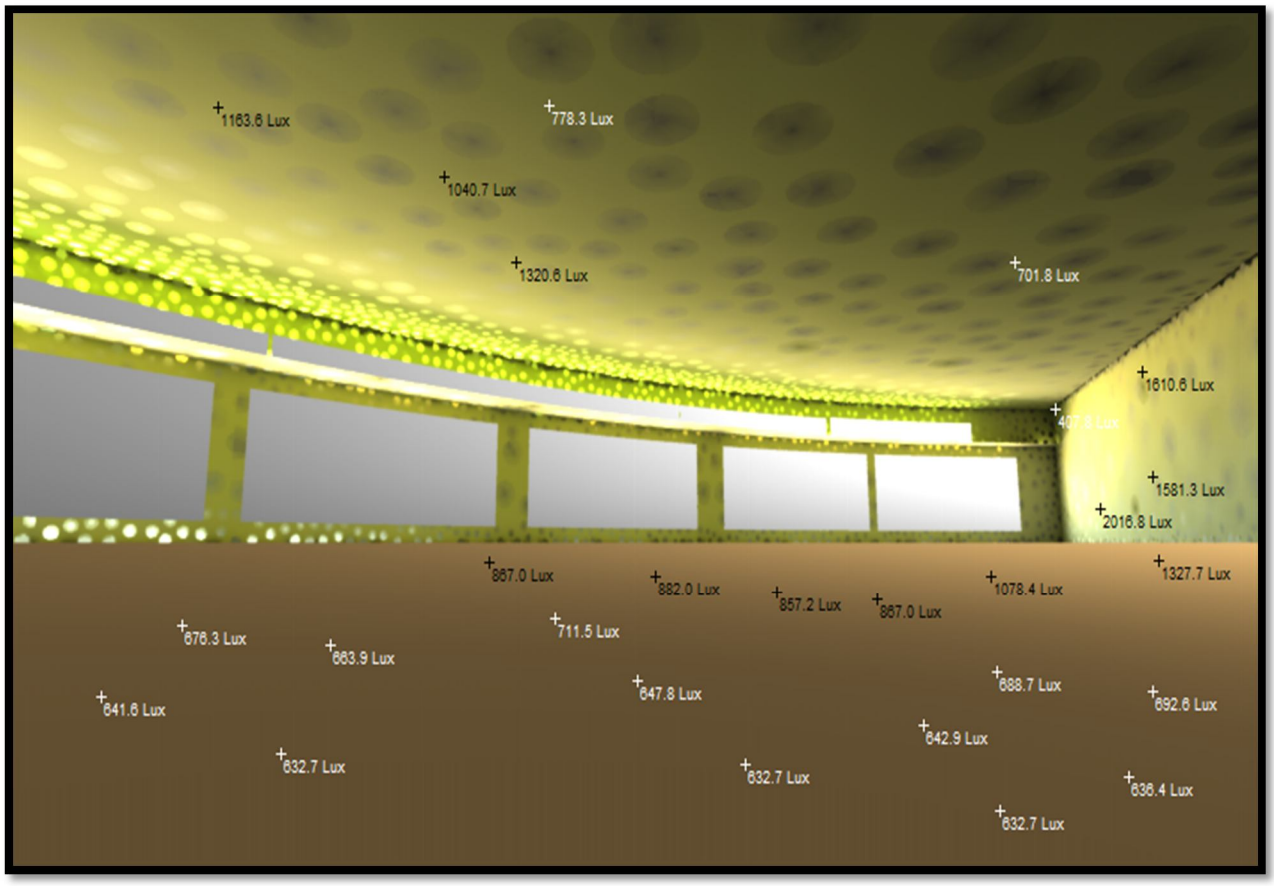


Figure 7.28: Rendered space at 10AM
Source: Researcher (2012)

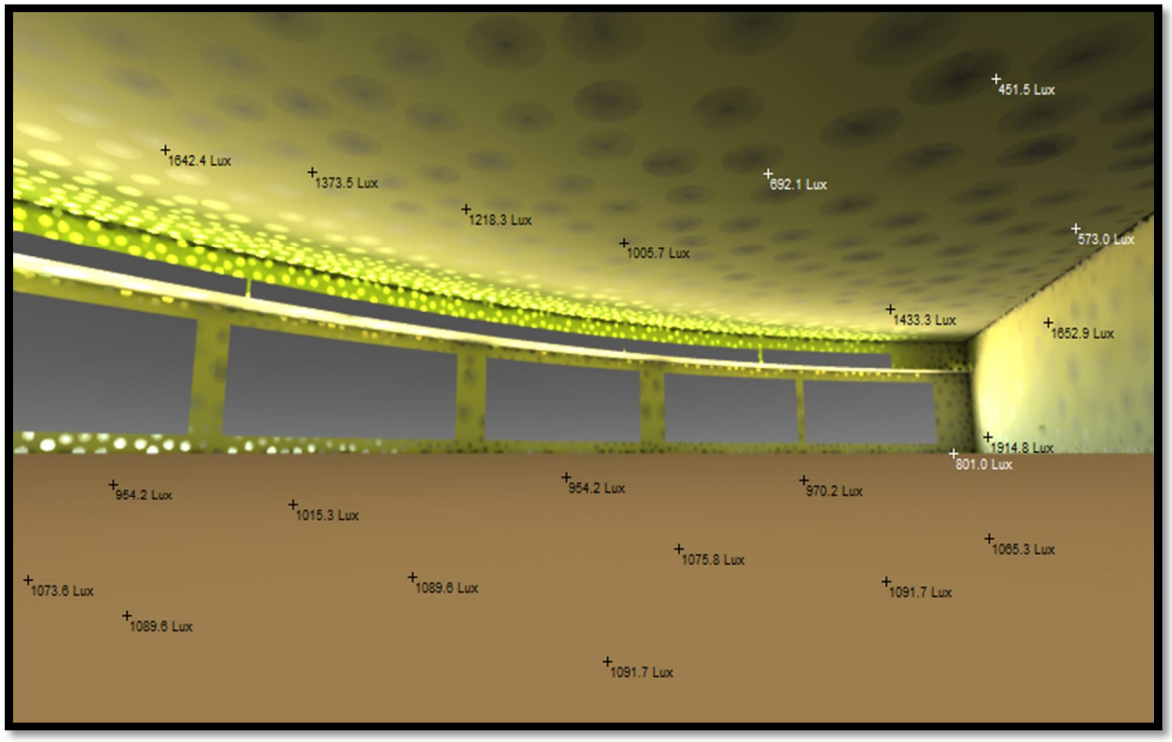


Figure 7.29: Rendered space at 12PM
Source: Researcher (2012)

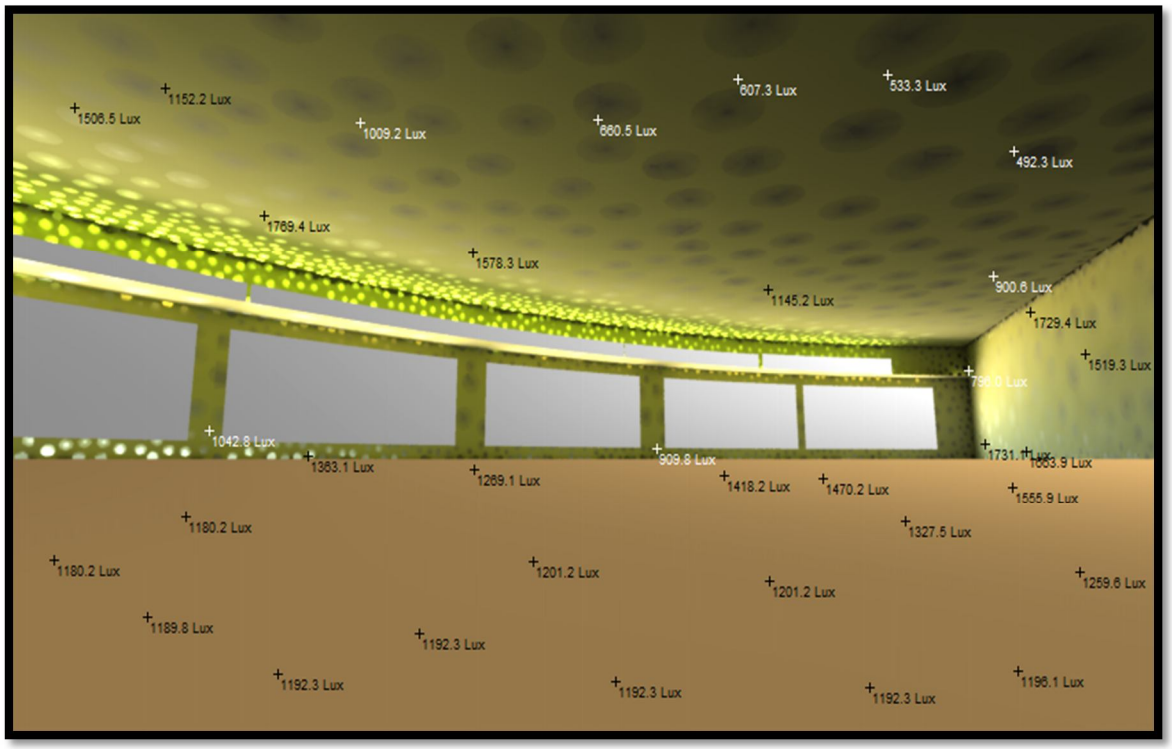


Figure 7.30: Rendered space at 2PM
Source: Researcher (2012)

7.10.7 CONCLUSION

The daylight simulations performed are subject to more experimentation. But for the purpose of this research, the analysis done is suitable for the purpose intend

CHAPTER EIGHT
CONCLUSION

8.1 SUMMARY OF FINDINGS AND CONCLUSION

This research is mainly about the application of daylighting in art centres to enhance art appreciation and at the same time guaranty the safety of the exhibit against weather forces. A major disadvantage of day light in the tropics is glare, but this can be avoided by proper building orientation, bi- directional lighting and careful choice of building finishes and glazing. Computer simulation using lighting design software, such as Radiance can help detect potential areas where glare can occur in buildings. These simulations can also aid in choice of day light elements to be used based on the quantitative and qualitative performance of the element

Ultimately the chief guiding principle in harnessing daylight in buildings is to consider natural light as a primary design consideration which affects all stages of the design, from site selection and preliminary design sketches to the choice of buildings finishes. As such the building form, building openings and finishes made use of in the design were dictated by their daylighting potential as well as their appropriateness for use in art centres.

From the analysis of case studies carried out, specifically the indigenous case studies and research conducted it can be seen that it is possible to make use of day lighting in Nigeria, as the illumination from natural light is adequate for the purpose. As the global search for environmentally friendly, cheap and renewable energy sources continues, the role played by natural light and energy from the sun in architecture will increase in relevance. Thus a country such as Nigeria that has an abundance of natural light which is relatively constant all year round has an immense gold mine which needs to be explored.

Spatial requirements for the various spaces within the art centres have been given utmost priority to form a concretized basis for allocation of space of art. Based on comparisons between

the standard space requirements for individual functions and those from case studies, the spaces required for the design of the centre for art was adopted. Following these, a schedule of accommodation was set out and a technical data stated.

The national art centre has facilities that will accommodate the various activities as provided by the brief in the scope of this dissertation. The art centre caters for a diverse category of audience as well as made provisions to serve a wide range of social activities.

8.2 RECOMMENDATIONS

i. From the case studies performed in Nigeria, there was very little attempt to use daylighting techniques and systems in art centres, more studies should be done to convince and introduce designers to different means of lighting exhibition spaces other than artificial means.

ii. A study to show the operating cost of art centres that use only artificial means of lighting and those that use both artificial and day lighting should be determine in terms of run time cost

8.3 CONTRIBUTION TO KNOWLEDGE

i. This thesis research through the use of computer simulation was able to document the typical illuminance levels obtainable through the use of light shelves, laminated glass windows and light pipes on days with bright design sky conditions of 9700lux level in Jos, plateau State at latitude 9.1° and longitude 9.4°.

ii. This research has shown proof that the use of daylighting can provide about as much good light as needed for the smooth functioning of an art centre in Jos, Plateau State.

iii. This research was able to analyze the various daylighting strategies that can be used to replace electricity such as the use of light shelves, the use of atriums, the use of tubular light pipes, the use of laminated glass for fenestration and the use of solar arrays.

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APPENDIX

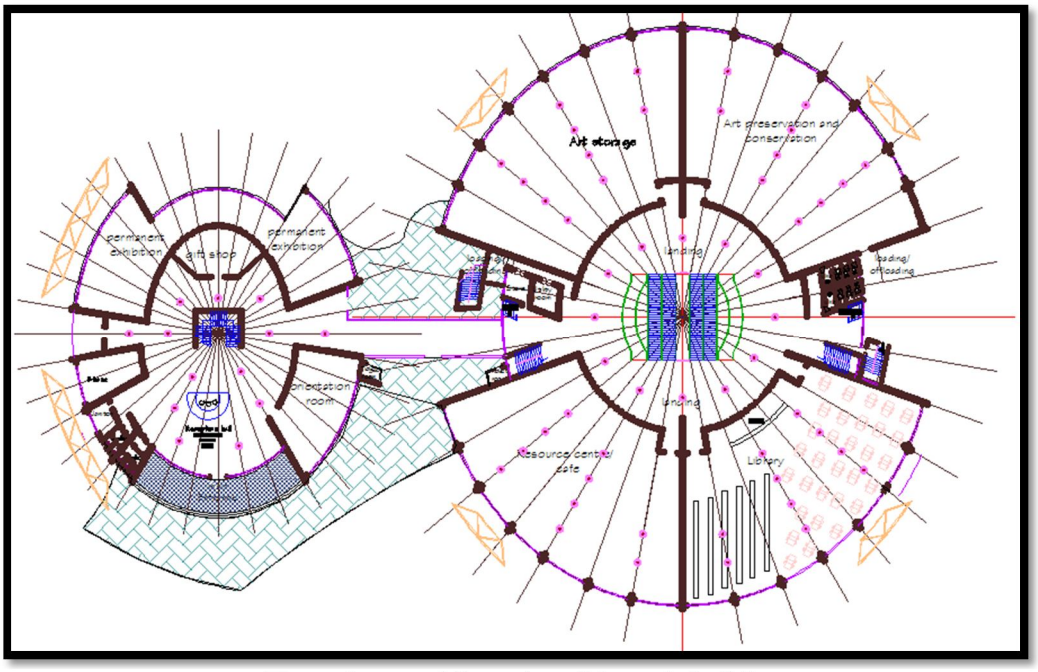


Figure 1: ground floor plan of the main building
Source: Researcher (2012)

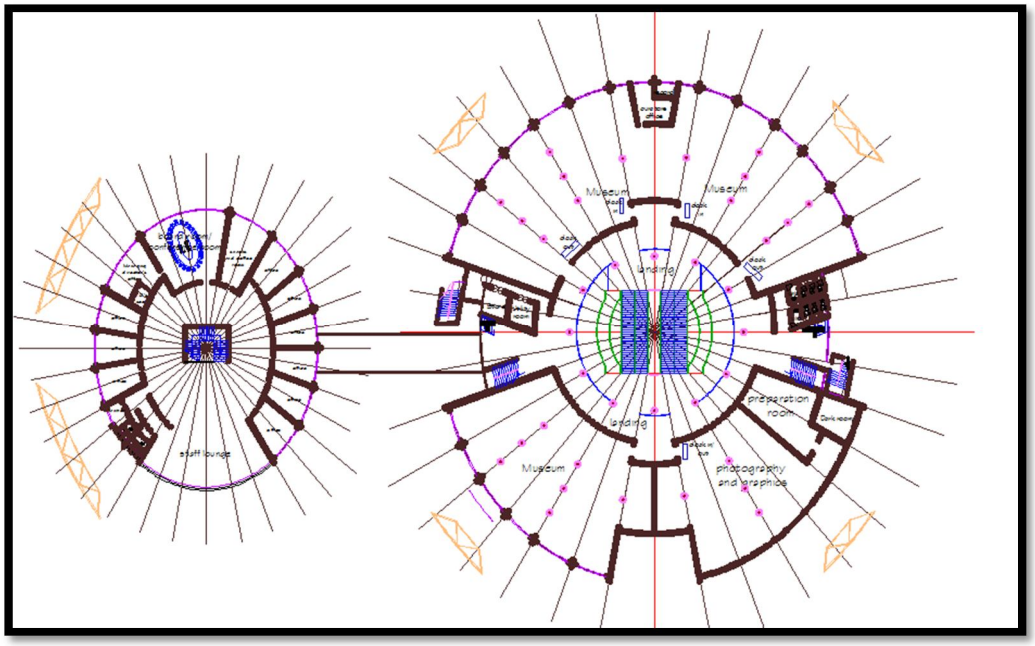


Figure 2: first floor plan of the main building
Source: Researcher (2012)

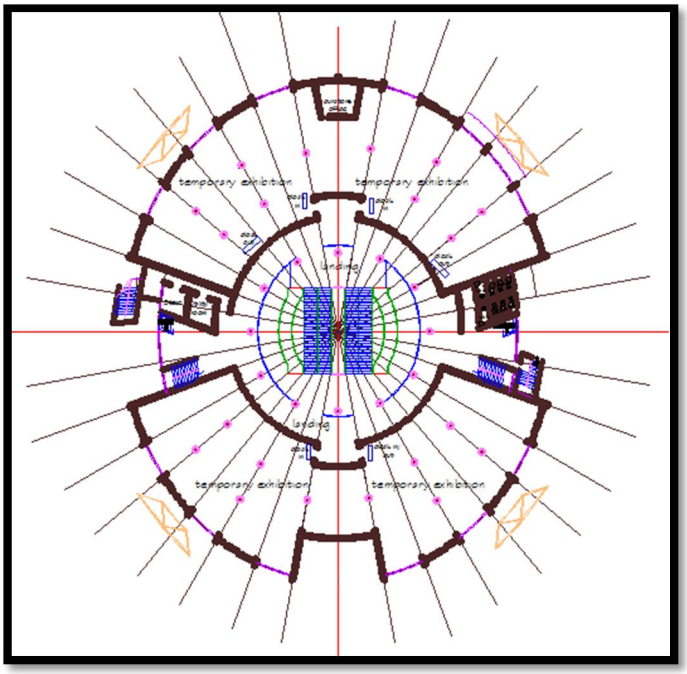


Figure 3: second floor plan
Source: Researcher (2012)

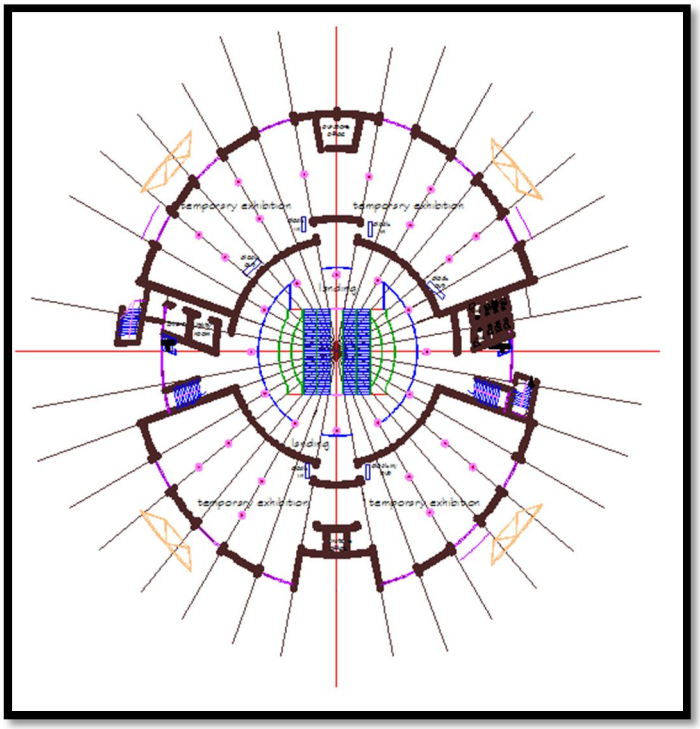


Figure 4: third floor plan
Source: Researcher (2012)

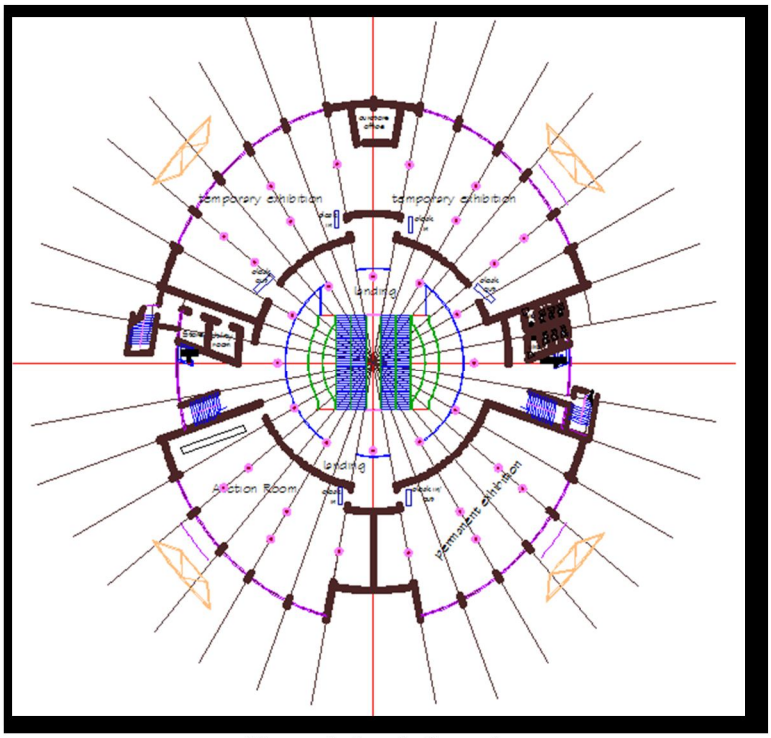


Figure 5: fourth floor plan
Source: Researcher (2012)

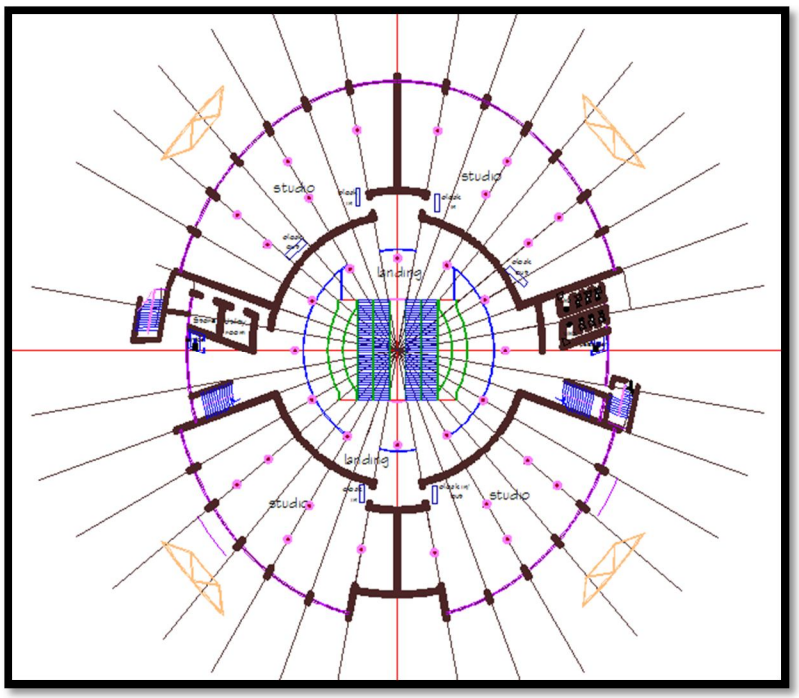


Figure 6: fifth floor plan
Source: Researcher (2012)

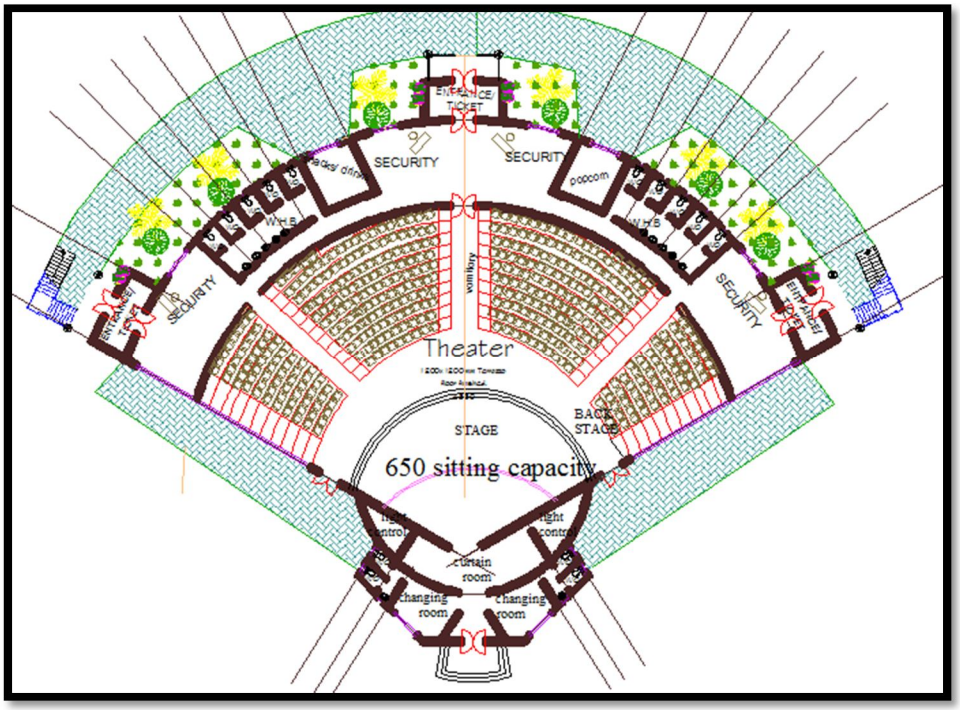


Figure 7: ground floor plan of the theatre
Source: Researcher (2012)

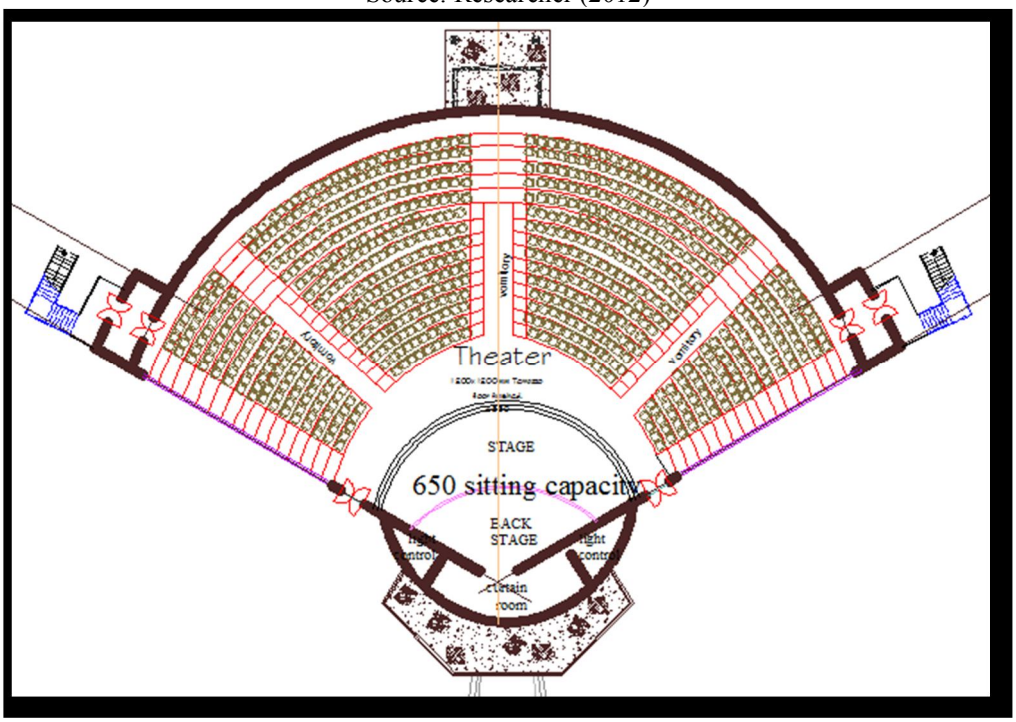


Figure 8: first floor plan of the theatre
Source: Researcher (2012)

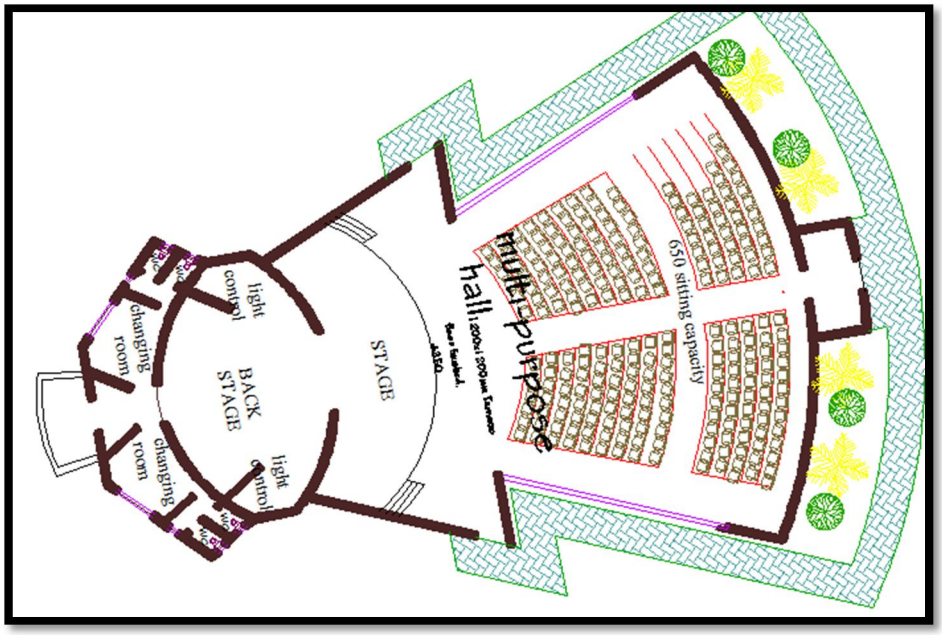


Figure 9: floor plan of multipurpose hall
Source: Researcher (2012)

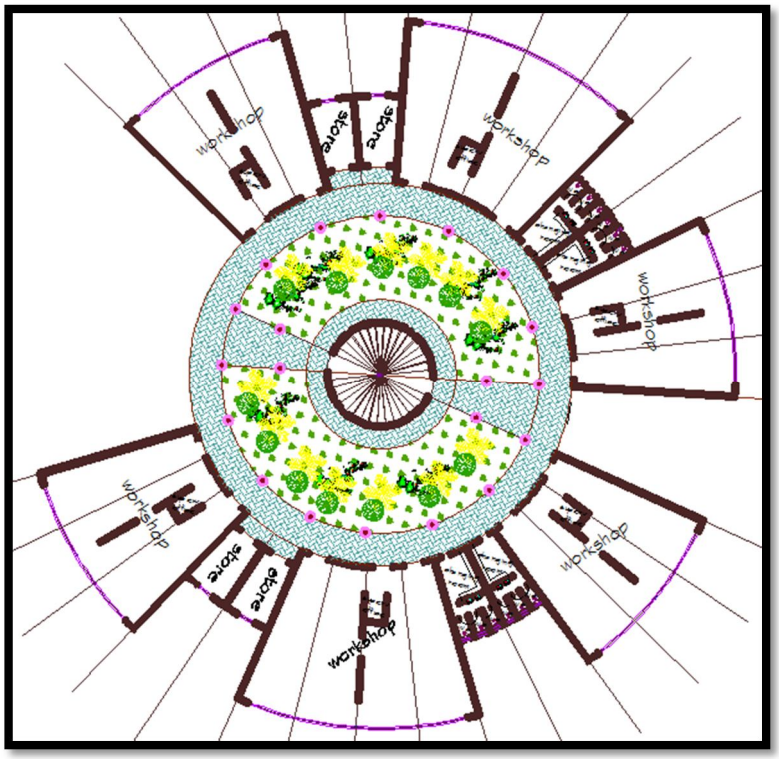


Figure 10: floor plan of workshop
Source: Researcher (2012)



Figure 11: floor plan of restaurant
Source: Researcher (2012)

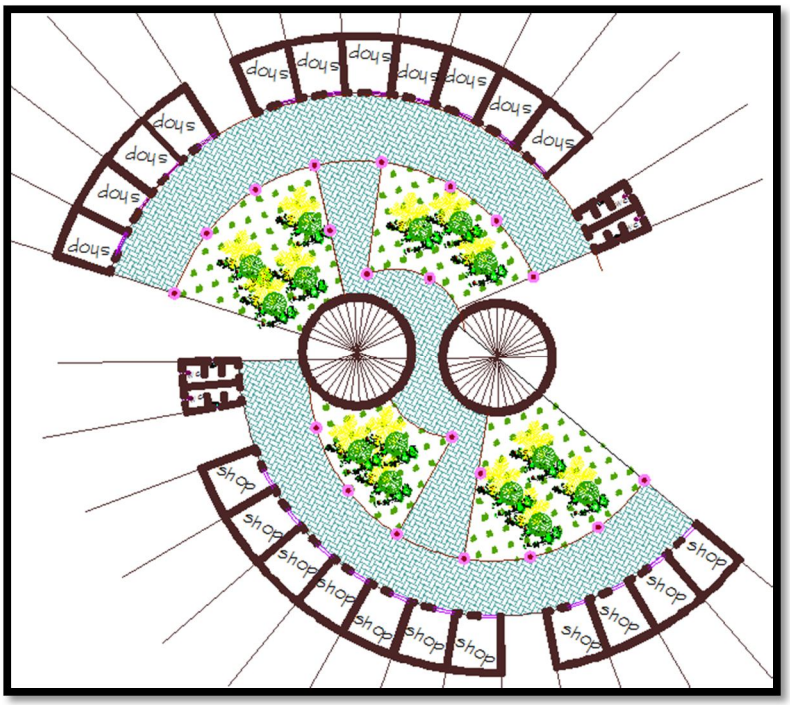


Figure 12: floor plan of retail shops
Source: Researcher (2012)

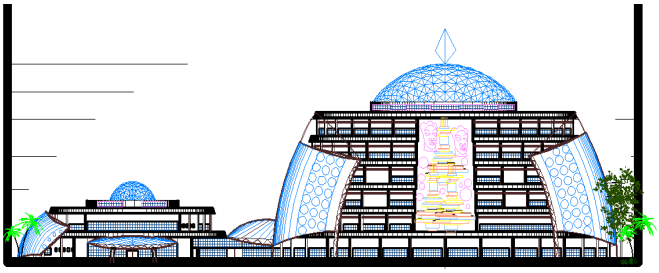


Figure 13: North Elevation
Source: Researcher (2012)

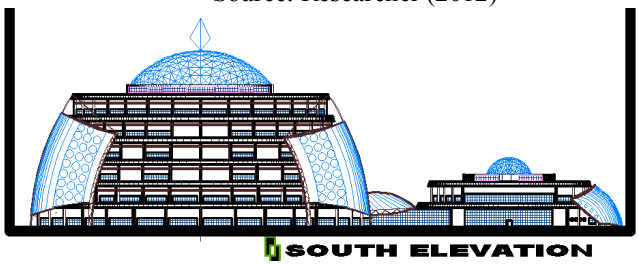


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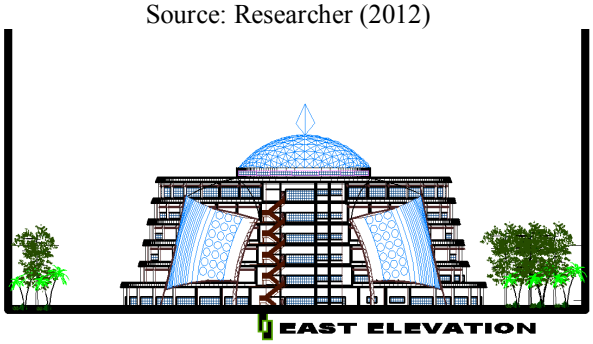


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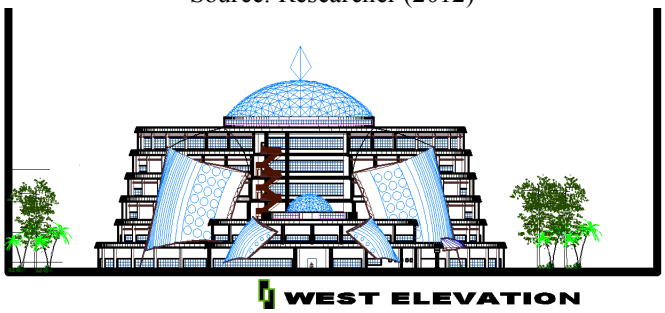


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Figure 17
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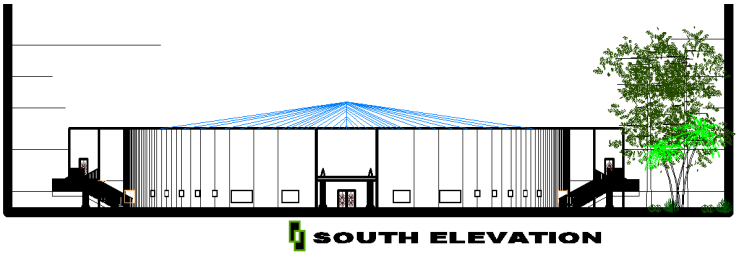


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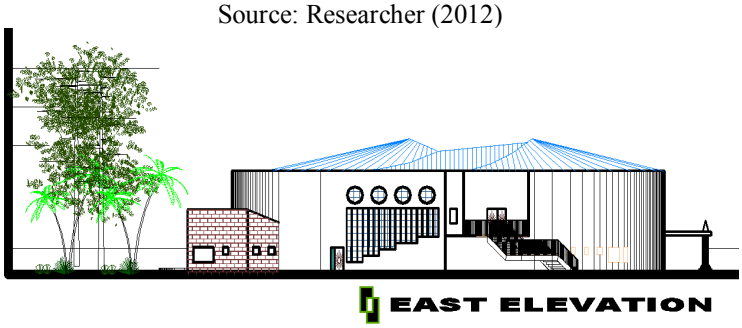


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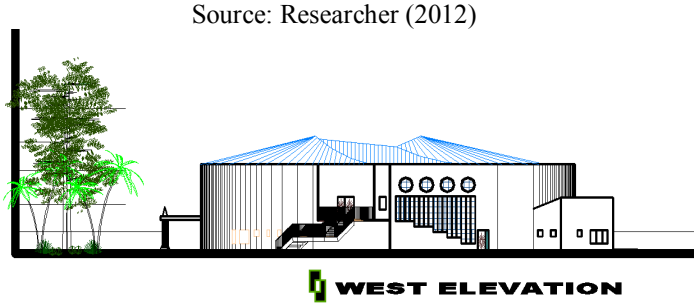


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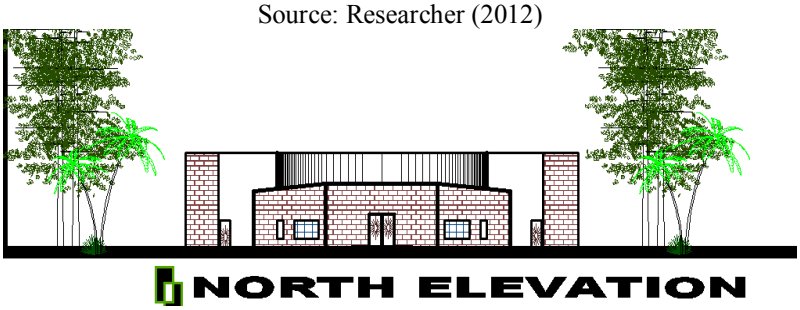


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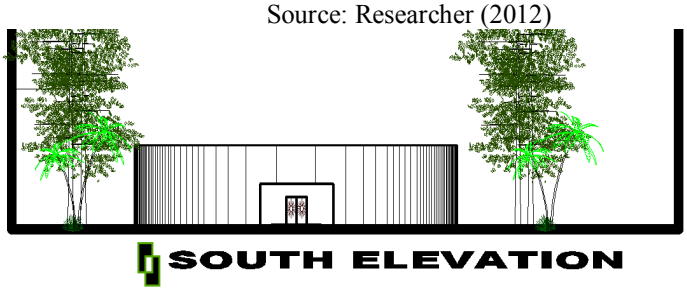


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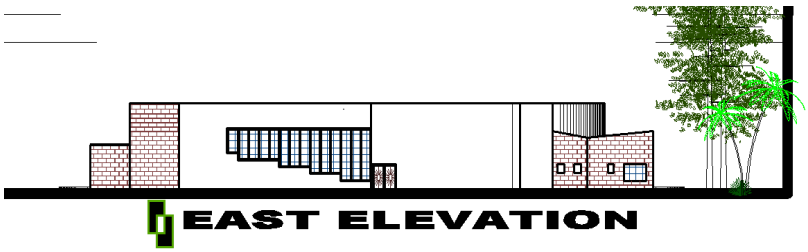


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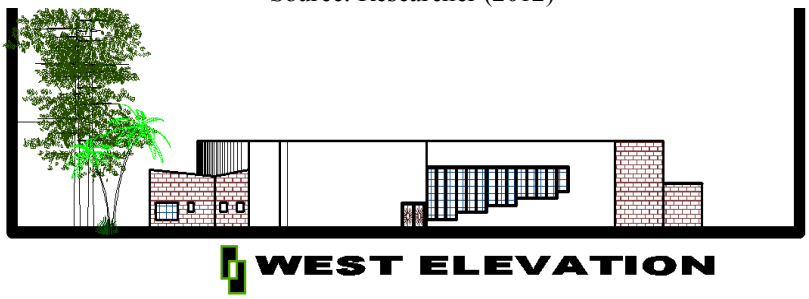


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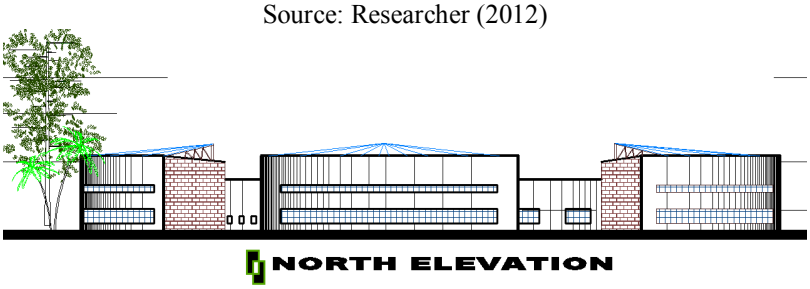


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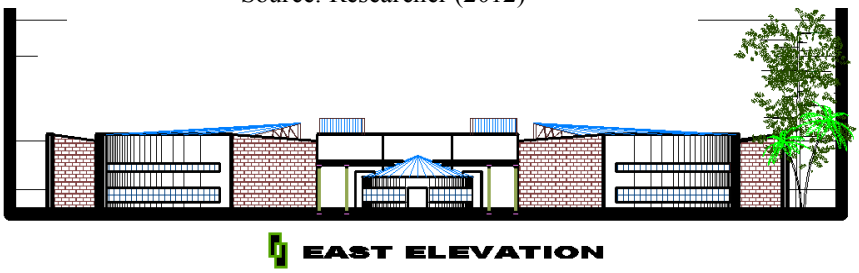


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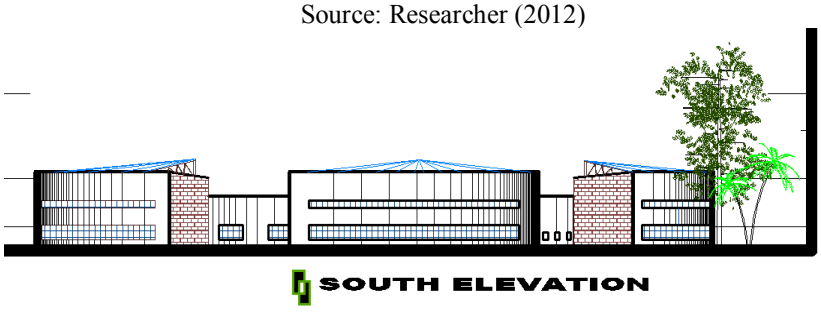


Figure 27
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Figure 28
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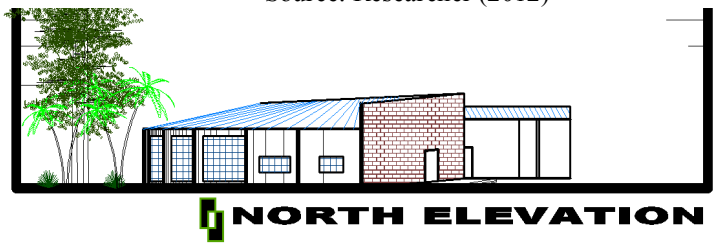


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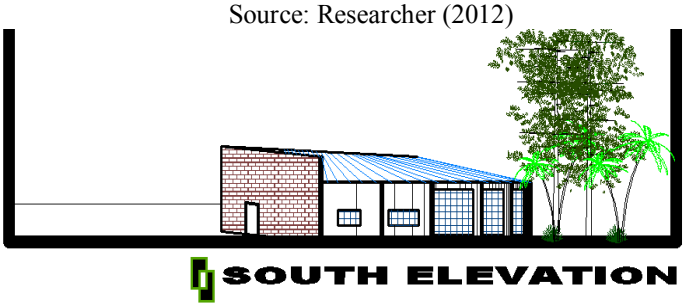


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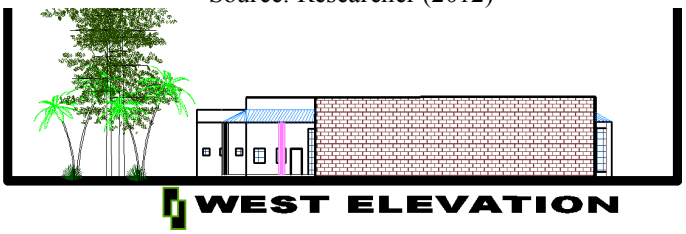


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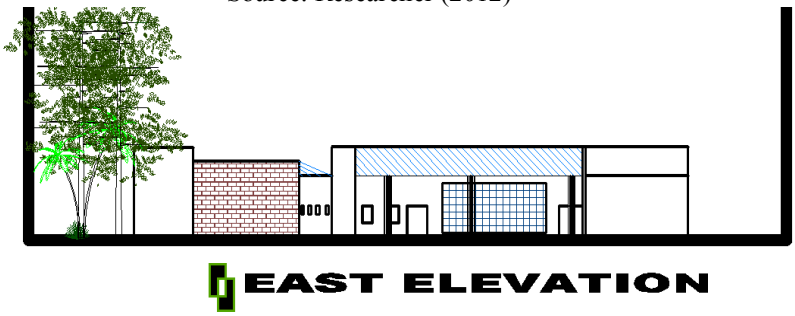


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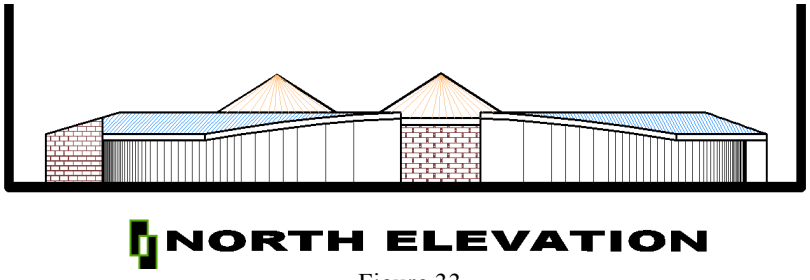


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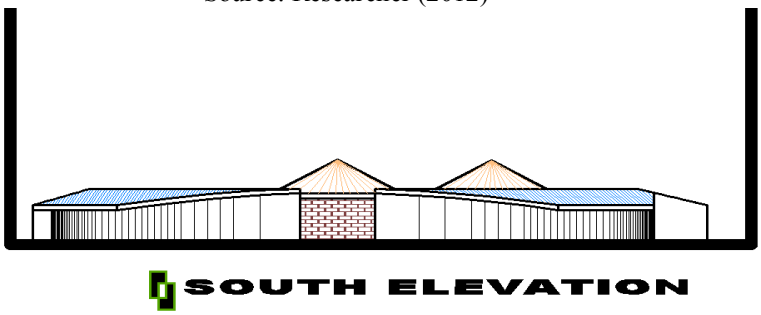


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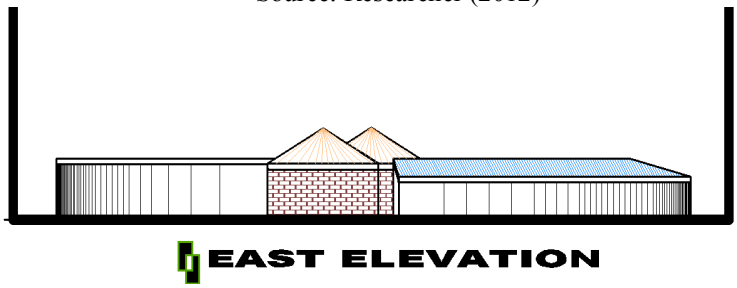


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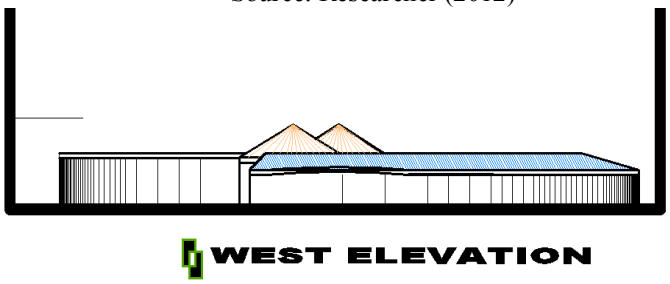


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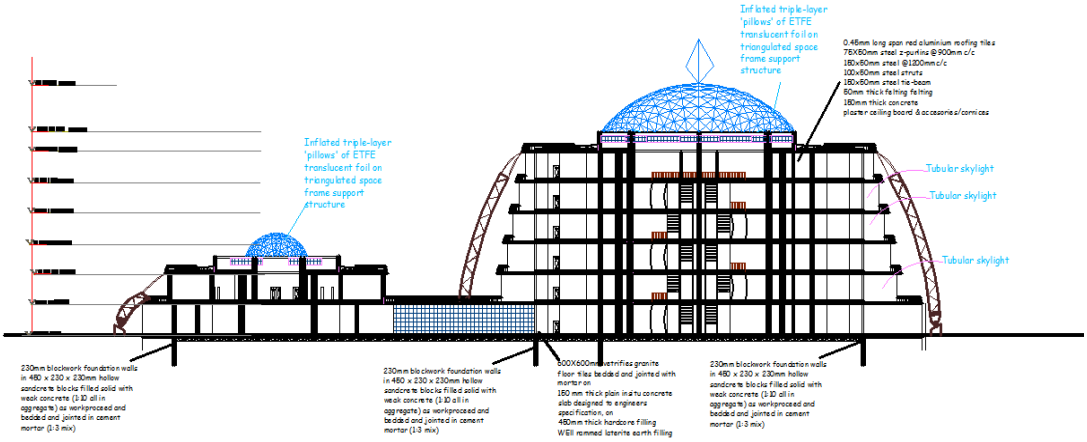


Figure 37: Section X-X of the main building
Source: Researcher (2012)

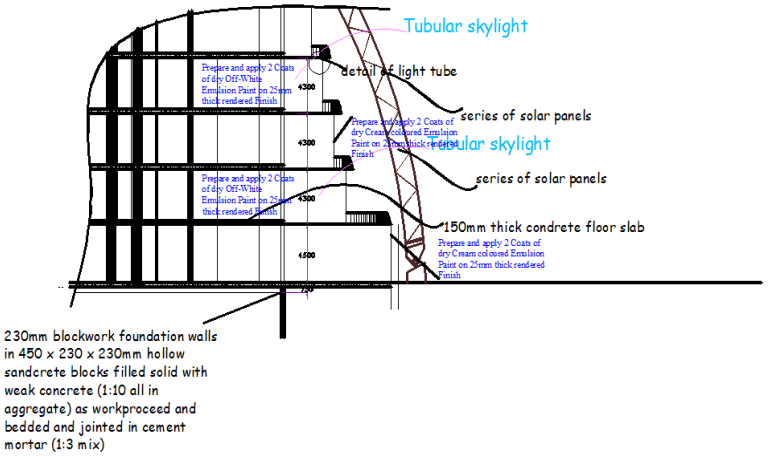


Figure 38: detail showing different daylight strategies
Source: Researcher (2012)

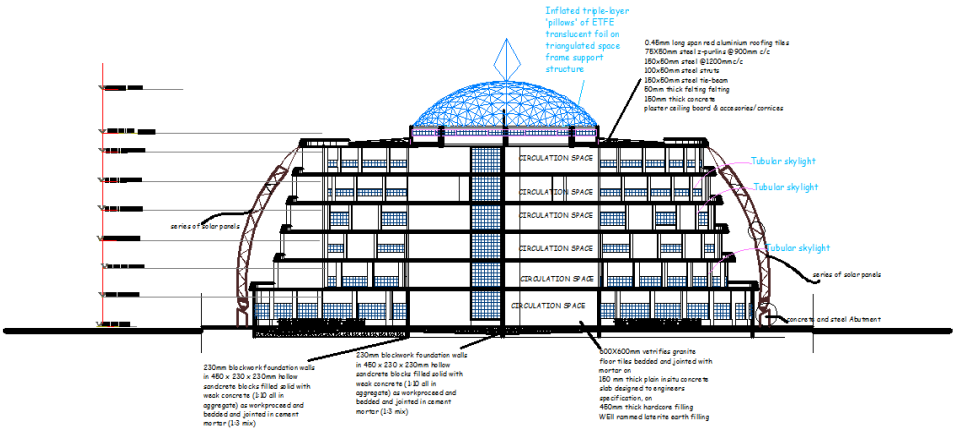


Figure 39: section Y-Y of the main building
Source: Researcher (2012)

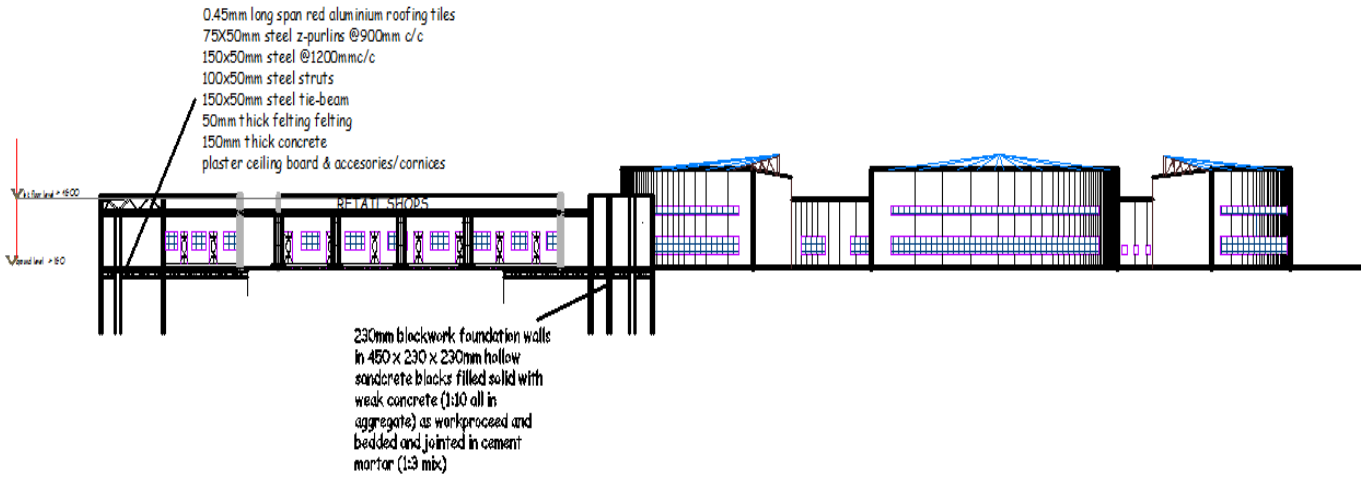


Figure 40: section B-B
Source: Researcher (2012)

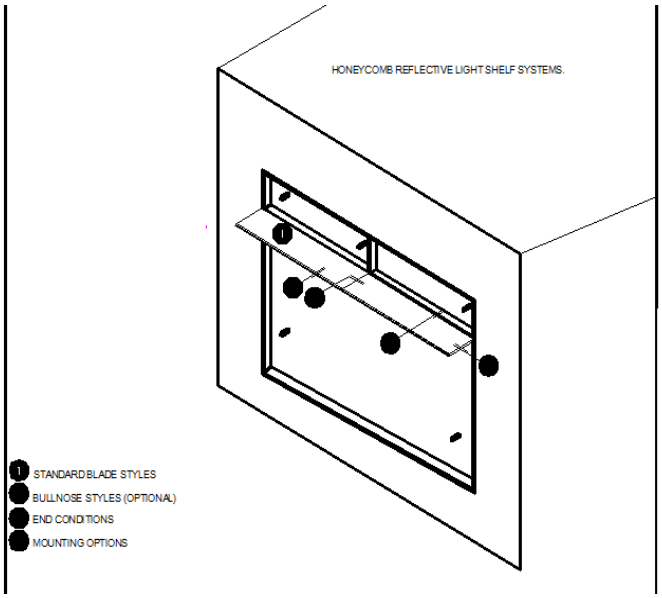


Figure 41: Details of light shelves
Source: Researcher (2012)

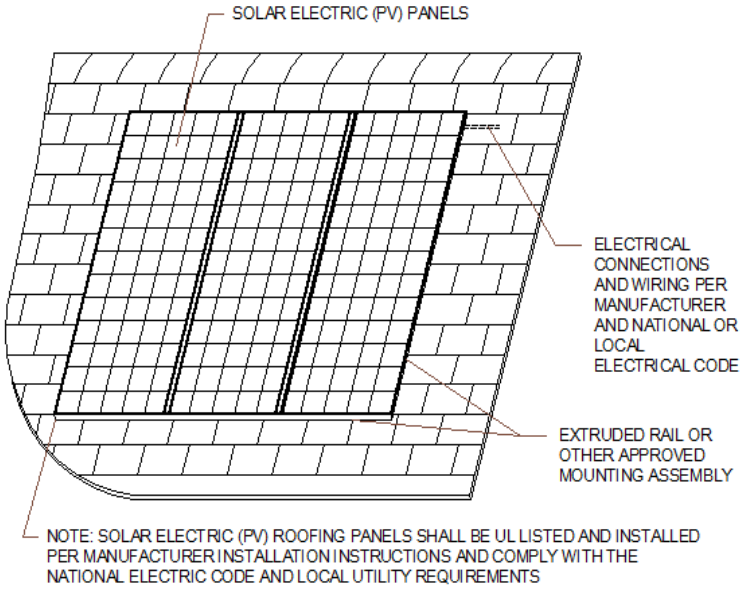


Figure 42: Detail of solar panels
Source: Researcher (2012)

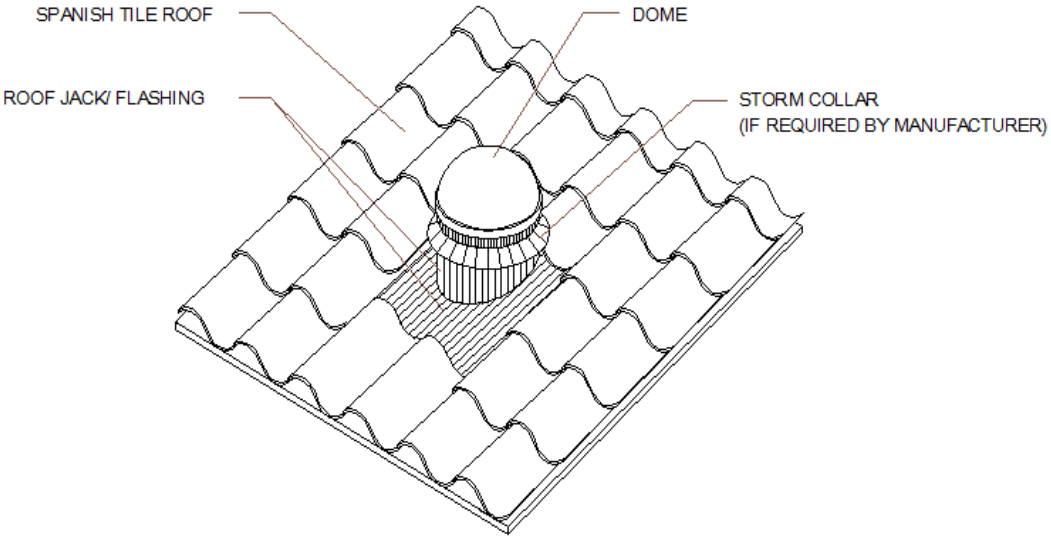


Figure 43: Detail of light tube
Source: Researcher (2012)

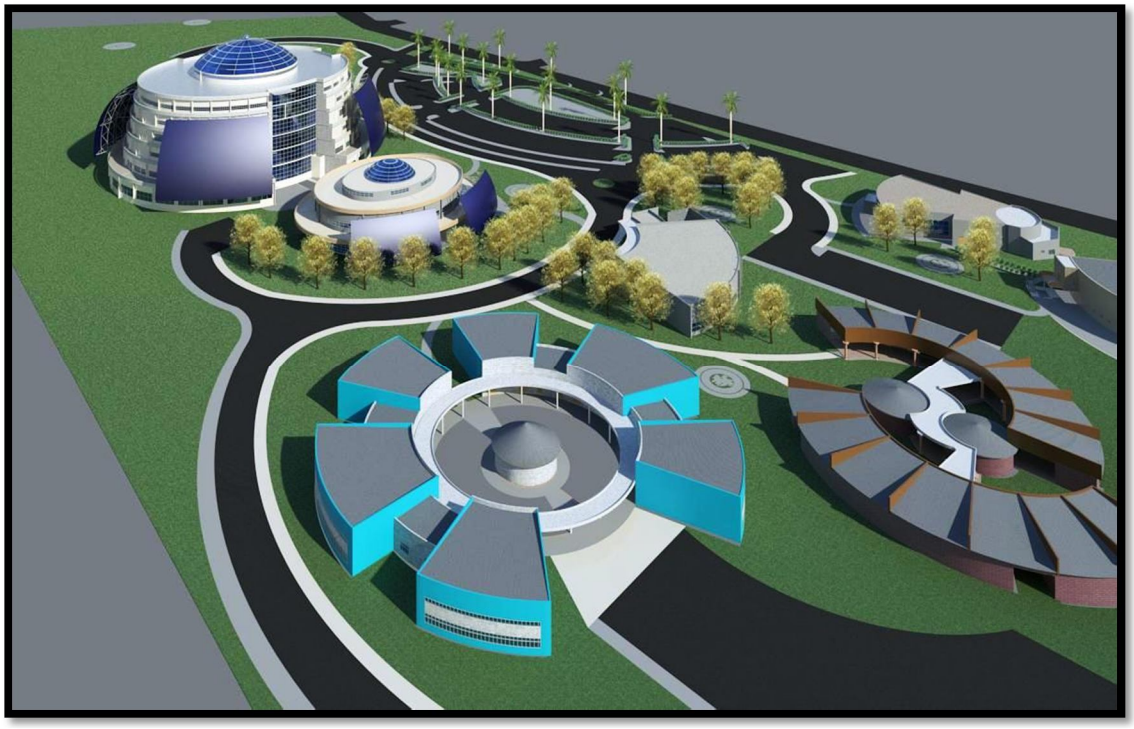


Figure 44: 3 Dimensional view
Source: Researcher (2012)

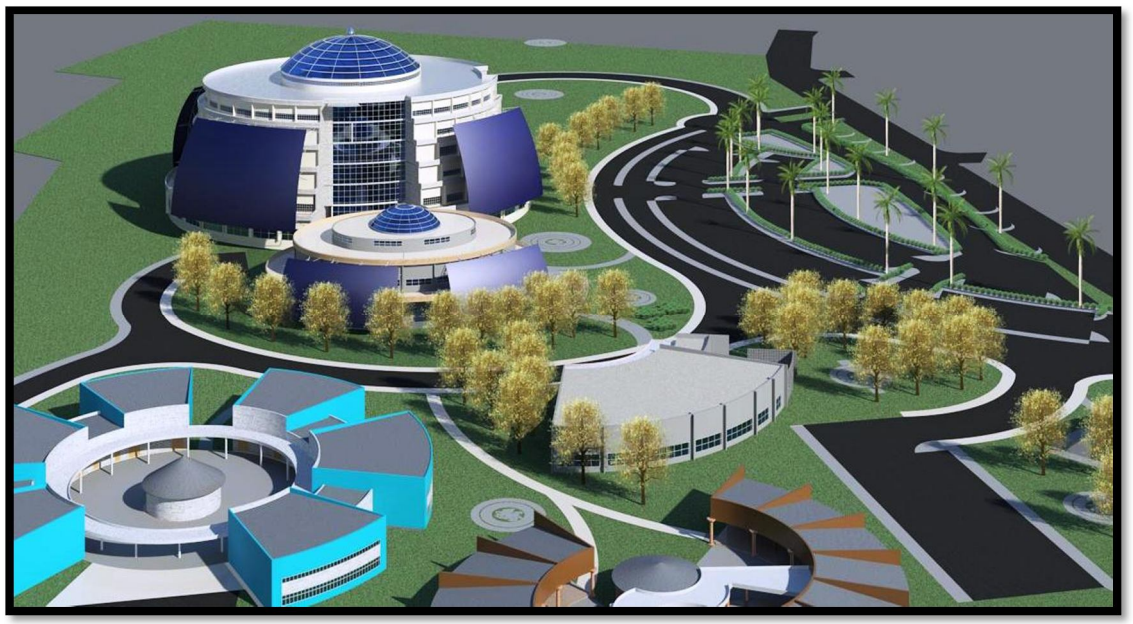


Figure 45: 3 Dimensional view
Source: Researcher (2012)



Figure 46: 3 Dimensional view
Source: Researcher (2012)