DESIGN PROPOSAL FOR
FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY,
IBRAHIMM BADAMASI BABANGIDA UNIVERSITY,
LAPAI, NIGERIA.
WITH EMPHASIS ON PASSIVE COOLING

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Abstract

Effective learning involves the use of computer-based hardware, software, and communication systems, to enable the acquisition, representation, storage, transmission, and use of information. Information and communication technology (ICT) has become, within a very short time, one of the basic building blocks of modern society. Many countries now regard understanding ICT, mastering its basic skills and concepts as part of the core of education, alongside reading, writing and numeracy. Student and researcher use ICT faculty to source information relevant to their area of study and also stay informed about what is happening around the world. The aim of this project is to lay the foundation for the sustainable transformation of IBB University into a world class citadel of learning by proposing a state of the art faculty information and communication technology. The faculty would contain; electronic library, cyber café, lecture rooms, seminar rooms, bindery unit, business centre and offices. It has been observed that most electronic device emit heat which later effect the efficiency of the device and make the surrounding environment unbearable to the user of such device. Therefore it is important to ensure that anybody in the faculty can reach and exploit information in an environment that is neither too cold nor too warm. The proposed design looked at the heat conductivity of the building material, and analyse the best material to be use in the construction of the faculty. The designs has provided inspirational learning environments shaped around people, and shall deliver improved environmental performance in the present; the building has the ability to incorporate further renewable energy in the future, as the economic and environmental contexts change. It has been observed that best approach to building construction that has good cooling technique is all about suitable practice, in terms of choice of material, construction methodologies as well as design philosophy.

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DEFINITION OF TERMS/ABBREVIATIONS

In order to have a clear understanding of this project, some terms and abbreviations have been selected and defined as follows:

I **INFORMATION TECHNOLOGY:** It refers to anything related to computing technology, such as networking, hardware, software, the Internet, or the people that work with these technologies.

II **PASSIVE COOLING:** Is a method of cooling a building that doesn't rely on mechanical methods of cooling to reduce the heating loads in a building; it is a means of reducing energy use and can lead to a healthier indoor air quality for your building

III **HIGH THERMAL MASS:** This is the ability of materials in the building to absorb heat during the day.

IV **EVAPORATIVE COOLING:** This is principle of allowing water to evaporate at the top of a tower, either by using evaporative cooling pads or by spraying water.

V **HVAC**: Heating Ventilation and Air-Conditioning.

VI **IT**: Information Technology.

VII **PHCN**: Power Holding Company of Nigeria.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Effective learning involves the use of computer-based hardware, software, and communication systems, to enable the acquisition, representation, storage, transmission, and use of information. Information and communication technology (ICT) is dependent upon being able to cope with the overall architecture of systems, their interfaces with humans and organizations, and their relationships with external environments. It is also critically dependent on the ability to successfully convert information into knowledge.

Information and communication technologies (ICTs) may be viewed in different ways. The World Bank defines ICTs as "the set of activities which facilitate by electronic means the processing, transmission and display of information" (Rodriguez and Wilson, 2000). ICTs "refer to technologies people use to share, distribute, gather information and to communicate, through computers and computer networks" (ESCAP, 2001). "ICTs are a complex and varied set of goods, applications and services used for producing, distributing, processing, transforming information – [including] telecoms, TV and radio broadcasting, hardware and software, computer services and electronic media" (Marcelle, 2000). ICTs represent a cluster of associated technologies defined by their functional usage in information access and communication, of which one embodiment is the Internet. Hargittai (1999) defines the Internet technically and functionally as follows: "the Internet is a worldwide network of computers, but sociologically it is also important to consider it as a network of people using computers that make vast amounts of information available. Given the two [basic] services of the system – communication and information retrieval – the multitude of services allowed…is unprecedented". ICTs, represented by the Internet, deliver "at once a worldwide broadcasting capability, a mechanism for information dissemination, a medium for interaction between individuals and a marketplace for goods and services" (Kiiski and Pohjola, 2001).

Information and communication technology is concerned with improvements in a variety of human and organizational problem-solving endeavors through the design, development, and use of technologically based systems and processes that enhance the efficiency and effectiveness of information in a variety of strategic, tactical, and operational situations. Ideally, this is accomplished through critical attention to the information needs of humans in problem-solving tasks and in the provision of technological aids, including electronic communication and computer-based systems of hardware and software and associated processes. Information technology complements and enhances traditional engineering through emphasis on the information basis for engineering.

The knowledge and skills required in information technology come from the applied engineering sciences, especially information, computer, and systems engineering sciences, and from professional practice. Professional activities in information technology and in the acquisition of information technology systems range from requirements definition or specification, to conceptual and functional design and development of communication and computer-based systems for information support. They are concerned with such topics as architectural definition and evaluation. These activities include integration of new systems into functionally operational existing systems and maintenance of the result as user needs change over time. This human interaction with systems and processes, and the associated information processing activities, may take several diverse forms.

It may be easier to define what ICTs are not: ICTs are not a panacea for development or a replacement for real-world processes. If the latter are flawed, deficient or absent, ICTs cannot make good the flaws or make up for the deficiencies. If a government process is bureaucratic, convoluted and subject to delays, moving it on-line may not make it any more efficient; and instant transmission may not necessarily make it any faster. If controls over financial systems are inadequate or missing, making systems electronic will not make them effective, and may in fact make it more difficult to trace the audit trail. This emphasizes the importance of having well-thought-out, well-established, clear real-world processes before moving them on-line. According to this view, ICTs can be an effective "and", rather than a substitute "or".

ICTs may, however, reshape, reorganize and fundamentally restructure working methods, and ultimately the sectors in which they are used. They offer generic advantages of efficiency gains, information-sharing, communication and faster knowledge accumulation, dissemination and application, in support of the specific purposes for which they are used. They also permit new, collaborative work methods through their potential for networking. Communication and interaction between previously isolated agents pool their individually isolated resources, knowledge and experience to build a common knowledge base upon which all members can draw. ICTs can transform work and research methods by enabling group interactions based on central reserves of shared knowledge. The evidence suggests that we are still on the threshold of what ICTs may achieve, and that these collaborative networking methods will evolve further, as people learn to communicate, interact and work in new ways. This makes ICTs a very exciting "and", and one that may transform the equation altogether.

1.2 STATEMENT OF PROBLEM

The information and communication technologies are now an integral part of the socialisation process. When a phenomenon becomes part of people's socialisation process, it inevitably becomes an inescapable concern for a number of social institutions. In the case of information and communication technologies, this characteristic is even more accentuated because these technologies perform important tasks or functions that support a number of individuals in their manual work (robotisation, automation, automated regulation, and so forth) or intellectual activities (modelling, simulation, graphic representation, translation, word processing, text correction), because they increase not only the resources but also the speed of communication (e-mail, electronic conferencing, electronic theme discussions, etc.) and help change the relations among individuals (such as written interaction, remote interaction, impersonal interaction) and between individuals and information/knowledge (document consultation, database consultation, thematic searching, videography and so forth). Any given society can react to such socialising forces by trying to prevent or limit their incursion into various fields of activity or relations. This brings about the need to have an information and communication technology faculty in order to make the phenomenon increasingly available and useful. This is because the present-day societies have adopted the latter approach to the information and communication technologies.

1.1 AIM

The study aims to design a structure that has minimal solar heat penetration which will enhance student's ability to interact, learn, and solve problems using modern computational tools and techniques.

1.2 OBJECTIVES

- To create learning environment that will require minimal amount of energy for cooling.
- To have a building that will cost less financially as well as environmentally.
- To minimize fuel consumption and lessening the environmental impact of building
- To integrate buildings with their natural environment by using of local bio-climate for environmental benefits.

1.3 DESIGN LIMITATION

Having set out the aim and objectives, it is also necessary to state the limitations which determine conclusions, arrived at in the work. Due to the absence of advance faculty of information technology in the country, the Nigerian information technology outfit is basically based on ICT center and cyber café. It is also difficult to obtain information, especially about the design of public building in Nigeria for security reasons, which will limit the complete understanding about some of the arrangement in some parts of the faculty, of which case studies were done. There was very few documented information about the research area. However, the limitations enumerated above do not foreclose the authenticity and value of this work.

1.4 IMPORTANCE OF THE STUDY

Digital Divide

Digitization has divide the world at present into “haves” and “have not’s”, those countries that have the capacity and ability to develop new digitalized networks and those that do not (Microsoft Encarta 2009). The concentration of economic power will be in the hands of those who now own quite different segments of media, from books to motion pictures and from cable to satellite and the opportunity of choice, offered to individuals will be genuinely widened. Most of the problem of the digital divide is not only related to acquisition and access to ITC, but also to the adaptability of these techniques by the society and the people worldwide, especially in developing countries where culture and language barriers have posed problem. This divide will be broken if manpower and proper measures will be put in place. The first thing that will be required is a well design infrastructure such as faculty of information technology where the manpower will be trained in new technologies , techniques and methodologies to develop high-quality products in the drive to bridge this divide and match up to the league of nations that are ITC complaint.

1.5. RESEARCH JUSTIFICATION

Information and communication technology (ICT) is increasingly moving to the core of national competitiveness strategies around the world, thanks to its revolutionary power as a critical enabler of growth, development, and modernization (GITR 2008-2009). Recent economic history has shown that, as developed countries approach the technological frontier, ICT is crucial for them to continue innovating in their processes and products and to maintain their competitive advantage. Equally importantly, ICT has proven instrumental for enabling developing and middle-income economies to leapfrog to higher stages of development and fostering economic and social transformation. All over the world, ICT has empowered individuals with unprecedented access to information and knowledge, with important consequences in terms of providing education and access to markets, of doing business, and of social interactions, among others. Moreover, by increasing productivity and therefore economic growth in developing countries, ICT can play a formidable role in reducing poverty and improving living conditions and opportunities for the poor. In these challenging times of global economic crisis, the extraordinary capacity of ICT to drive growth and innovation should not be overlooked, since it can play a critical role not only in facilitating countries' recovery but also in sustaining national competitiveness in the medium to long term. At the World Economic Forum, we are strong believers in the link between economic growth and ICT readiness, a link that should be further emphasized in the face of the current severe economic downturn and calls for budget cuts (GITR 2008-2009).

1.6. THE DESIGN PHILOSOPHY

Faculty of Information Technology

It is important to ensure that anybody in the faculty can reach and exploit information in an environment that is neither too cold nor too warm. Passive cooling is important both for one's well-being and for productivity. It can be achieved when the building design relies on rules of thumb for harnessing the power of wind for the purpose of natural ventilation, building location and orientation, building form and dimension, landscaping and material usage.

CHAPTER TWO

LITERATURE REVIEW

2.1 INFORMATION AND COMMUNICATION TECHNOLOGY

Information and communication technology (ICT) has become, within a very short time, one of the basic building blocks of modern society. Many countries now regard understanding ICT and mastering the basic skills and concepts of ICT as part of the core of education, alongside reading, writing and numeracy (UNESCO 2002).

One of UNESCO's overriding aims is to ensure that all countries, both developed and developing, have access to the best educational facilities necessary to prepare young people to play full roles in modern society and to contribute to a knowledge nation.

The use of Information Communications Technologies in Development (ICTD) programming is not new. However, in 2000 they assumed a new prominence, when the United Nations and G8 group of industrialized countries flagged ICTD as a global development priority (UNDP et al. 2001). Since then, the understanding of ICTD as a core development issue has been rapidly evolving.

Few would disagree that technology underpins the unprecedented levels of prosperity enjoyed by developed countries. The world entered the 20th century without planes, radios or televisions. It enters the 21st with nuclear power, space travel, computers, cell phones and the wireless Internet. Within the span of a hundred years, entirely new fields of science and technology came into existence and the fundamental political and economic structure of the world changed not once, but several times. The scope and pace of recent change is a function of revolutionary advances in Information Communications Technologies.

2.2 HISTORY OF INFORMATION AND COMMUNICATION TECHNOLOGY

The history of ICT originates from humble beginnings, which include the abacus. The abacus is thought to have been originally invented 3000 years before the birth of Christ. Revisions to its use/design continued for many years e.g. 500 BC a bead and wire version is developed in Egypt. Early versions of the calculator were gradually replacing this primitive method of mathematics. In 1624 Wilhelm Schickard built the first four-function calculator-clock at the University of Heidelberg, thus heralding a new era.

Mechanical versions of the calculator followed in the years to come. Calculators as we know them couldn't have existed until 1780, when Benjamin Franklin discovered (through experimentation) electricity. The 1st general purpose computer was designed by Charles Babbage around the year of 1833. In 1855 George and Edvard Scheutz built a practical model based on Babbage's original designs. The 1st electronic calculator (named the Z1) is built by Konrad Zuse in 1931. In the year of 1940 at Bell Labs, the Complex Number Calculator is tested and then demonstrated. This is thought to have been the first digital (pulse wave rather than analogue wave run) computer.

Quickly approaching the computers that we use today, 1971 was the year that the Intel Corporation released the 1st microprocessor (the Intel 4004.) Macian E. Hoff was thought to have been the leader of the project. The PC as we know it today was created by IBM and released during 1981. Apple introduces its PC alternative, the Macintosh, during 1984. It features a GUI (Graphical User Interface) which gave the IBM PC's DOS (text-based) run system stiff competition due to its usability and professional software.

The World Wide Web is developed by Tim Lee in 1991, and CERN also creates the 1st Web Server. The Pentium chip is included in PCs for the first time in 1993 signalling the end for the 486.

2.2.1 SUPERCOMPUTERS

A supercomputer is the most advanced type of computer (or collection of computers in one large tower) available. They are used for calculations that are too complex for the average computer i.e. for processing and predicting weather from thousands of individual ever changing files of information. An example of a modern supercomputer is IBM's ASCI Purple. It cost 250 million dollars and was built for the Department of Energy (USA.) This computer harnesses a peak speed of 467 teraflops and could be used for purposes such as to simulate aging or the operation of nuclear weapons. Supercomputers were first introduced in the early seventies when Seymour Cray unveiled the Cray 1.

2.3 EVOLUTION OF INFORMATION AND COMMUNICATION

Humans have relied on communication from time immemorial to relay messages to one another. Nowadays, we use complex technology to send important information to our loved ones, friends and business associates. However, the technologies we use today did not always exist. Human beings have relied on various methods to communicate with each other. These methods have depended on the progress science had made at that time.

2.3.1 DRAWING

Prehistoric cave drawings are considered the first form of human communication. Some early humans dwelt in caves, which provided shelter from the elements and predatory animals. To convey past events of importance, rituals or ideas, cave dwellers would draw pictures on the walls of their homes. Language had not developed to the point at which it was adequate to convey these concepts, so drawings communicated what words could not.

2.3.2 WRITING

Written language developed as humans settled into agrarian communities. The switch from hunting-based societies to non-nomadic lifestyles based on agriculture took place roughly 9,000 years ago. Writing became important as humans recognized the need to keep records of property and trade. At first, pictures represented the objects that were being written about. As societies developed further, pictures then represented sounds. Ultimately in the West, the language of pictures gave way to letters, which were graphic representations of particular sounds. Stringing letters together created words.

2.3.3 PRINTING

For hundreds of years, documents were written by hand, which could be time consuming. The skill of writing was confined to an elite, well-educated class, most of whom were clergy. In the 14th century, block printing became popular. Block printing involved using individual etched wooden blocks to print single words or letters. This process was expensive and inefficient. In 1454, German goldsmith Johannes Gutenberg invented a printing machine that contained movable blocks. Gutenberg's invention revolutionized book production, making books affordable and accessible.

2.3.4 TELEGRAPH

The invention of the printing press certainly made it easier to communicate, but it could take days or weeks for the written word to arrive at its destination. Scientists searched for a faster way to transmit information. French scientists developed a communication system that used light to transmit signals in the late 18th century. American inventor Samuel Morse improved this system by creating a machine that transformed speech into electric signals and then into written words. His telegraph became a popular method to communicate quickly.

2.3.5 TELEPHONE

The invention of the telegraph was the inspiration for further advances in communication technology. Using the principle behind the telegraph, American inventors Elisha Grey and Alexander Graham Bell transformed speech into an electrical signal. Unlike the telegraph, this electrical signal was transformed back into speech. This invention ultimately became more popular than the idea it was based on, and the telegraph became a thing of the past.

2.3.6 DIGITAL TECHNOLOGY

Computers represented a huge leap in communication technology. Originally, computers were used perform complex mathematical equations. Eventually, scientists realized that computers could be used to communicate as well. The precursor to the Internet was created in 1989, and it allowed scientists to share documents with each other through their computers. It was not long before the Internet became publicly accessible. This technological innovation made communication faster than ever before.

2.4 RESEARCH AREA

Buildings are the major economic sector in the world and the quality of buildings shapes the life of citizens (Santamouris et al 2006). With the market for mechanical air conditioning steadily increasing across the world and with the rising instance of global warming, this is becoming a concern in hot climate countries. Additionally the environmental impact of chemical refrigerants has already been documented as one of the fundamental reasons for green house gas emissions (Bhowal 2010). A mechanically conditioned building will cost more both financially as well as environmentally. Properly designed naturally ventilated buildings therefore provide a significant opportunity for minimizing fuel consumption and lessening the environmental impact of the act of construction.

Traditionally all vernacular architecture has elucidated interesting solutions of imparting thermal comfort through natural means. Passive cooling including experimentation with down draught ventilation and forced air techniques has often proved to be an economical solution to natural ventilation for public buildings. A successful combination of such concepts for a public building with a large volume of occupants at a given time was the objective of building a passive structure described in this paper.

In an era in which information and energy have structural roles in society, it is herein proposed a reflection on the transformation of the ways of life occurred over the last decades and the impact it has on the demand of new space functions and types. The incorporation of new housing functions calls for a new approach to the design of public space, in which the diversity of conventional spaces must interact with the inclusion of new multifunctional spaces that accommodate activities such as tele-work and tele-health in order to respond to the growing demand of information access and of comfort in buildings. In addition, it is hereby acknowledged that the construction industry is, of all human activities, the main responsible for energetic consumption, and therefore, it is necessary to reduce the negative environmental impact of buildings both in the sheer construction, in maintenance, and in rehabilitation.

The construction process has a huge negative impact on the environment for it consumes and uses up considerable natural resources. Construction alone, on the one hand, generates the emission of polluting agents and, on the other, creates waste that to be processed requires, in turn, more consumption of resources.

This consumption cycle proceeds during the use of the building and it aggravates itself towards the end of its lifespan. Not only does this phenomenon occur at the building level but also at the city level (Mourão 2005).

There is the need for Architects and designers to look for opportunities to capture re-use and recycle the energy, water, materials and waste resources available on site so as to minimise energy consumption and resources. The integration of buildings with their natural environment and the use of local bio-climate for environmental benefits is fundamental to design.

Sustainability is measured by a “triple bottom line”; proposals need to be economically viable, socially equitable and environmentally sound. These three broad themes inter-relate throughout design, and optimising the synergies between them in an imaginative way is key to producing quality school buildings. Sustainable thinking has played a key role in generating exemplary educational buildings and master plans. Whether an innovative technology academy or a low energy school for students with learning difficulties, the overriding aim is to create socially progressive and resource efficient designs which can be done using passive means of stabilizing the thermal heat gain and heat lost in buildings.

The term "passive" implies that energy-consuming mechanical components like pumps and fans are not used. Passive cooling in building designs, attempts to integrate principles of physics into the building exterior envelope so as to; Slow heat transfer into a building which involves an understanding of the mechanisms of heat transfer: heat conduction, convective heat transfer, and thermal radiation (primarily from the sun), remove unwanted heat from a building. In mild climates with cool dry nights this can be done with ventilating.

2.5 PASSIVE COOLING

Keeping buildings cool in the hot season can use a lot of energy. This is particularly true of large buildings such as schools and offices. And as we feel the effects of climate change, our demand for cooling is likely to increase. But relatively simple techniques are increasingly being used to cut down on the energy needed to keep us comfortable.

Passive cooling is a method of cooling a building that doesn't rely on mechanical methods of cooling to reduce the heating loads in a building; it is a means of reducing energy use and can lead to a healthier indoor air quality for your building. (Encarter 2009).

Passive cooling refers to technologies or design features used to cool buildings without power consumption.

A building's structure (or an element of it) is designed to permit increased ventilation and retention of coolness with the intention of minimizing or eliminating the need for mechanical means of cooling.

There are three basic methods of passive cooling; removing, absorbing and blocking heat. These can be used separately or together to maximize the ventilation, high mass cooling, and evaporative cooling.

2.6 PASSIVE COOLING STRATEGIES

As energy costs rise in the world, and the public becomes more aware of the environmental damage arising from current energy use patterns, more people are looking into passive cooling as a way of reducing the amount of energy used in their home. In most of Nigeria, just as much energy, if not more, may be used for cooling in dry season. Thus, a properly designed building, whether it is solar or not, should be designed to require a minimum amount of energy for cooling. This project will discuss the major passive and low energy cooling methods applicable to buildings. In general, the strategy for reducing cooling energy in the building is as follows:

- Block heat from entering
- Minimize heat generated
- Ventilate to remove heat and move air
- Natural Ventilation
- High Thermal Mass
- Evaporative Cooling

- Select Energy-Efficient Appliances
- Use Appliances Wisely

There are two factors which determine dry season comfort: temperature and humidity. Although passive cooling measures can be very effective in controlling temperature, they are generally incapable of removing the moisture from humid air. Therefore, it may be necessary to use an air conditioner from time to time for dehumidification. Humidity control is important not just for comfort reasons, but to prevent moisture problems such as mildew growth in closets. The goal of air conditioning is to provide comfort for the occupants of the house, not to maintain a particular temperature setting, but to appease the thermostat on the wall. If a breeze is passing through the room, your perception of the temperature will be lower than that measured by the thermostat because the movement of air allows your body to lose heat more effectively.

2.6.1 BLOCK HEAT FROM ENTERING

2.6.1.1 Shading

One of the simplest and most effective methods of blocking heat from entering the home is shading. There are many different methods available to provide shading both inside and outside the house. Most are very simple and can easily be retrofitted to an existing structure. In general, exterior shading is more effective than interior because it blocks the heat before it enters the house. Interior shading, while effective at blocking sunlight from reaching the center of the room, still allows heat to enter the house, where it is trapped between the shade and the window. In addition, some types of exterior shading may be used to shade the walls and roof, as well as windows, thus reducing their temperature and heat transmission to the inside. Interior shading, however, has the advantages of being easily controlled by the occupants of the house while also not being exposed to wind and rain. A combination of both indoor and outdoor shading maximizes both heat reduction and controllability.

a. Exterior Shading

- **Landscaping**

Landscaping is an effective and pleasant means of providing shading for a building. An effectively planned landscape will block out the hot harmattan sun, encourage warming sun

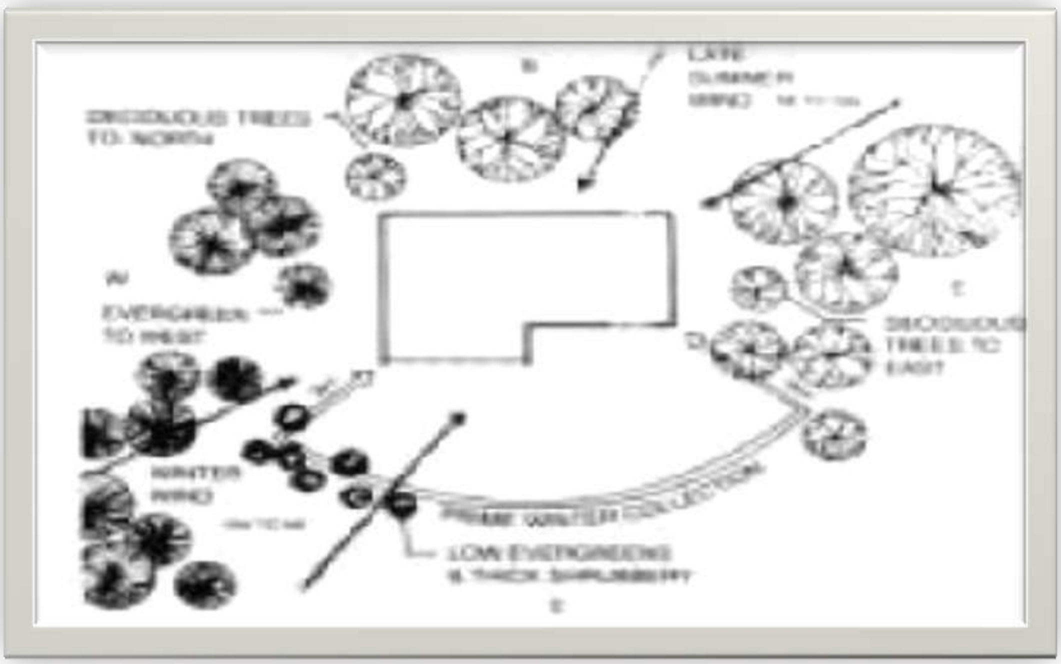


Plate I: Showing how a Building is Shaded from Sun

SOURCE: South Carolina Energy Office Energy Brief

to enter the house in winter, deflect the cold winter winds, and channel breezes for cooling in summer. In general, an “ideal” landscape plan for the faculty would include trees to the east and west of the building in order to provide shading, with the area to the south of the building left relatively clear in order to allow solar heating in winter. Trees will be most effective if they shade east and west windows, where the most heat can enter, but shading east and west walls and the roof is also important. Even trees which do not directly shade the house, such as those planted to its north, are valuable because they reduce the temperature of the air surrounding the building.

- **Roof Overhangs**

A roof overhang is a simple architectural feature which can be used on the south side of a building to block direct sunlight in dry season without reducing the available sunlight in winter. Plate 2 illustrates how this is possible: because the sun travels a higher path in the sky in the summer than in winter, the overhang blocks direct sunlight from entering,

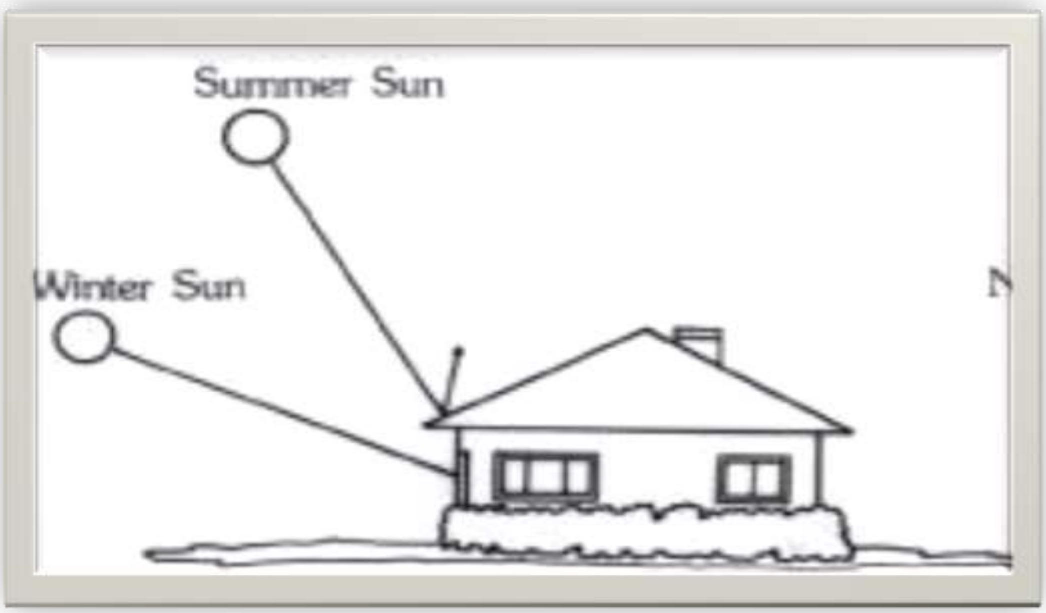


Plate II: Showing a Roof Overhang Protecting the House from the Sun

Source: South Carolina Energy Office Energy Brief while the lower winter sun passes beneath the overhang. Overhangs do not work as effectively on orientations other than due south, however, because the sun is at lower angles in the sky when it shines from the east or west, thus bypassing the overhang. Overhangs may be a permanent part of the buildings structure, or may be used seasonally. An important point to remember about overhangs is that they block direct sunlight. This does not imply that overhangs are not useful; it just means that they should be used in conjunction with some other cooling strategies, such as interior shading, to be fully effective.

Plate III: Shading Overhangs

Source: South Carolina Energy Office Energy Brief

- **Awnings**

Awnings serve the same general function as an overhang, but are more flexible in their application. Made of lightweight materials such as aluminum, canvas, acrylic, or polyvinyl laminate, it is possible for them to span distances of several feet without the need of extra support, thus making it possible for them to provide adequate shade even on the east or west. They are also frequently designed to extend below the top of the window, increasing their shading effectiveness. Awnings can be custom-made to match the home exterior, making them an attractive design feature for many buildings. They may have open or closed sides. Side less awnings can shade east and west windows effectively, but for south windows, awnings with sides will give better protection against the early morning and late afternoon sunlight. To avoid trapping heat underneath the awning next to the window, the awning must have some means of allowing heat to escape, either through open sides or from a vent at the top. To be most effective, awnings should be light in color. Permanent awnings may be appropriate for use on the east or west side, but awnings on the south side need to be retractable or removable in cold season in order to allow in sunlight for heating.

Plate IV: Awning with Slats.

Source: South Carolina Energy Office Energy Brief

- **Exterior Shade Screens**

Solar shade screens are a very effective shading option. Made of a thick fiberglass mesh which absorbs the sunlight, they are effective against diffuse and reflected, as well as direct, sunlight. Consequently, they are capable of blocking up to 70 percent of all incoming sunlight before it enters the windows. Because most varieties can also serve as insect screening, they also allow the use of natural ventilation, unlike some other shading options (such as interior or exterior shades) which block air flow. Shade screens come in a variety of colors. From the outside, most shade screens appear darker than a standard window screen, however, from the inside, most people will not notice an appreciable difference in color. In addition to fiberglass mesh, there is another type of shade screen which uses thin louvered metal fins to reflect the sunlight. This type is more expensive, however, and is used more frequently on public buildings than residences. Shade screens should be removed in winter to allow full sunlight to enter the windows.

- **Shutters and Shades**

Exterior shutters and shades either hinged or of the rolling blind type, are another option for shading. Although they block sunlight very effectively, they have a few disadvantages: they obscure the view from the window, block daylighting, and may be inconvenient to operate on a daily basis. They are also subject to wear and tear, and may block air flow.

Exterior shutters may be operated manually or automatically. Automatic controls are more costly and difficult to maintain, but may be more practical than manual controls when the shutters are at inconvenient locations. Proper use of the shutters is also more likely when they are automatically controlled rather than depending upon compliance by members of the household.

Another variety of exterior shutter, the Bahama shutter, is hinged at the top and projects out from the window at an angle, held in place by a rod or wood strip. In practice, it shades more like an awning, allowing in daylight and ventilation. Unlike other exterior shutters, it may be operated from the inside.

b. Interior Shading

While interior shading is not as effective as exterior shading, since it is unable to block heat until it has already entered the building, it can still be a useful supplement to exterior shading. It is used where other shading options are unavailable. Interior window treatments are normally considered a necessity for privacy and as part of the houses decor. Proper selection of window treatments can make them an asset for cooling as well.

Draperies and curtains are most effective when made of tightly-woven, opaque material of a light or reflective color. The tighter the curtain fits to the window, the better its ability to trap heat and prevent it from entering the house. Simple white roller shades shade quite effectively when fully drawn, but prevent light and air from entering. Venetian blinds, while not as effective at trapping heat, will allow air and light to pass through, while reflecting some of the sun’s heat. Some newer blinds are coated with special reflective finishes.

c. Reflective Films and Coatings

Reflective coatings which adhere to glass can block up to 85 percent of incoming sunlight. Some coatings may be applied seasonally; others are permanently affixed to the glass surface. Permanent films or coatings are not appropriate for south windows in passive solar buildings, since they would block heat from entering all year round. However, they would be practical for unshaded east or west windows.

Window films are not recommended for windows which receive partial shading, because the film absorbs the sunlight and will cause the glass to heat unevenly and possibly crack.

d. Radiant Barriers

For roofs which are unshaded, radiant barriers provide another way to block heat from entering the building. A radiant barrier is a layer of aluminum foil placed in an air space between a heat-radiating surface (the roof of a building) and a heat-absorbing surface (the insulation on the floor of your attic). It works to reduce the heat entering the building in two ways: its reflective surface reflects most of the radiant heat striking it, and it will itself emit very little heat.

Radiant barriers come in many different forms: single sided or double-sided foils, foil-faced insulation, and multilayered foil systems with air spaces. Any of these products should perform equally well if properly installed, so the cost of the product and its ease of installation should guide the decision between them.

To work properly, the shiny side of the radiant barrier must face an air space. The orientation of the shiny surface itself does not matter; it will reflect heat equally well whether it points up or down. What is important is that the surface remains shiny. Hanging the radiant barrier with its shiny side down prevents dust from accumulating on its surface and reducing its ability to reflect heat.

2.6.2 Minimize Heat Generated

Not all of the heat in building in hot season comes from the sun; much of it comes from the occupants of the home and the appliances they use. By carefully selecting appliances and the times when they are used, the occupants of the faculty can help keep the house cooler.

2.6.3 Ventilate To Remove Heat and Move Air

Ventilation, or the movement of air, is one of the most powerful means of achieving a passive cooling in building. Ventilation has two goals: (1) to remove heat from the building and (2) to provide air movement within the bulding to cool its occupants. There are several different types of ventilation, both natural and mechanical, which meet these goals in different ways. Though mechanical ventilation measures are not strictly passive, they are a much less energy-intensive method of achieving a cool building than air conditioning.

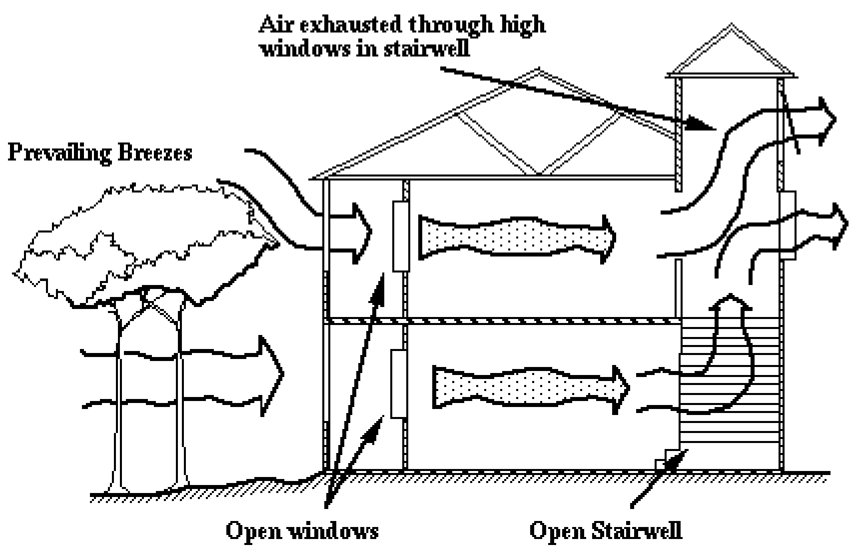


Figure 2.1: How Building is Ventilation Through Openings

Source: Author 2011

2.6.4 Natural Ventilation

Natural ventilation, or relying upon summer breezes to generate air movement within the house, is the simplest of passive cooling strategies. Due to the variability of wind speed and direction, though, it can also be the least reliable. However, careful selection of windows and their positioning can help enhance the natural ventilation possibilities of a building.

2.6.4.1 Principles of natural ventilation

The main driving force that causes natural ventilation through buildings is the pressure differential across the building envelope. This pressure difference can be generated by wind pressure, thermal buoyancy (stack or chimney effect) or by a combination of both. These effects operate in a building in varying proportions according to the strength of the prevailing wind and the temperature conditions.

The effect of wind pressure is a highly complex subject and when generalized in this field, can often lead to erroneous architectural strategies. In principle, airflow occurs between areas of positive and negative pressure.

Cross-ventilation occurs between these polarities of pressure. One empirical design rule is that *openings should be widely distributed over individual surfaces and different facades of the building envelope. This ensures that the openings will be at different pressures and that the subsequent airflows will be well distributed in the building* (Baker 1999). In the pages below we will see some of basic factors affecting natural airflow in and around buildings.

The resistance to flow of air through the building affects the actual airflow rate. Natural ventilation and infiltration are driven by pressure and suction across the building envelope as indicated in the diagrams below in figure 2.2.

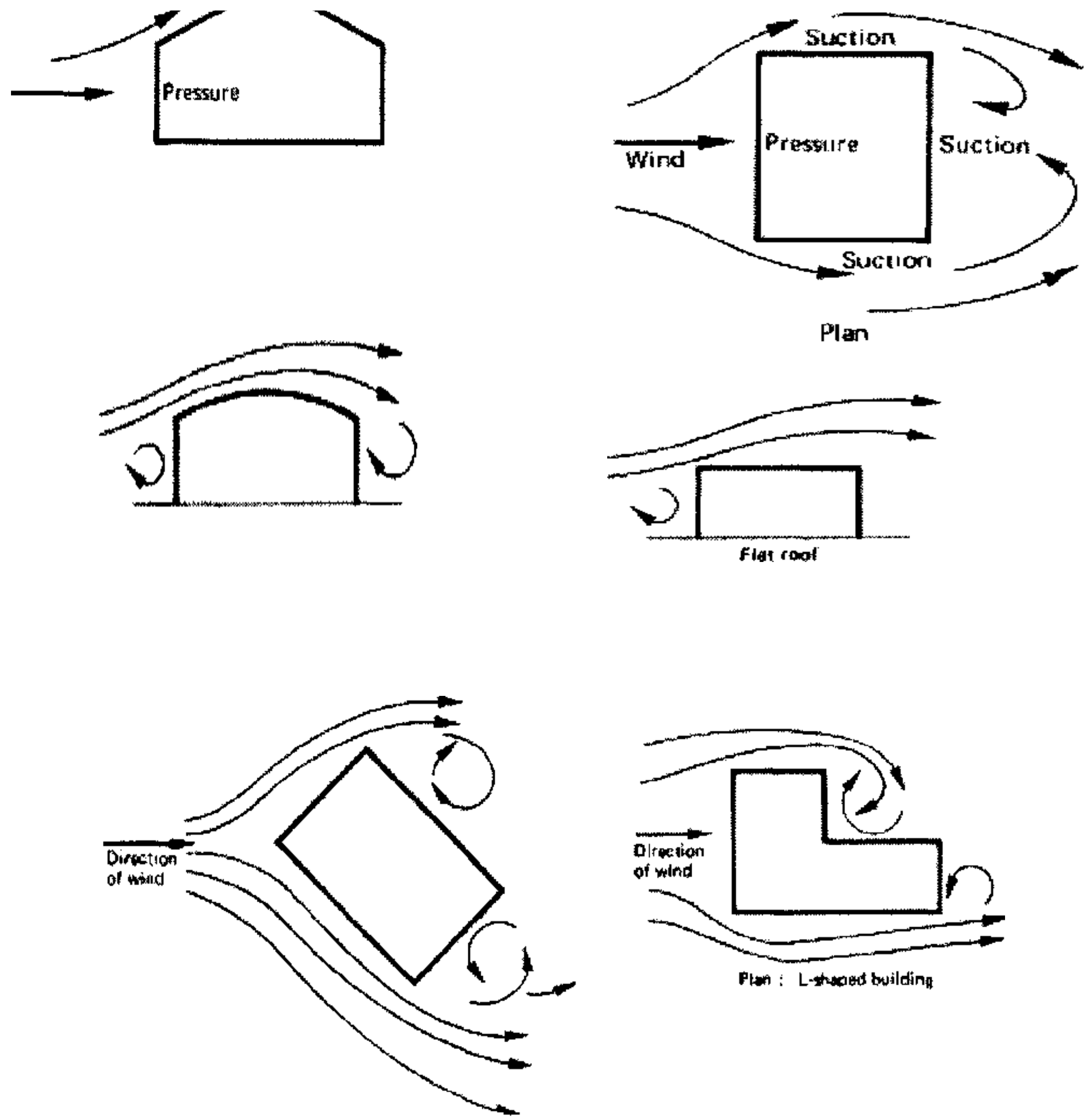


Figure 2.2: Wind Pressure, Suction, and Wind Flow Around the Building.

source: Bittencourt 1993

The shape and orientation of the building relative to the direction of the wind are both directly related to the way in which the airflow behaves around volumes. Other obvious factors affecting airflow patterns around the building are the topography, the physical relationship to surrounding volumes and obstacles: other buildings, fences, vegetation etc. The relationship between high and low rise buildings, for instance, can cause turbulence increasing the air velocity resulting in greater wind pressures *(Fig.2.3).* The positioning of buildings within the suction zone of other structures can also have a considerable impact on the amount of air going through the air inlets of naturally ventilated buildings. In order to avoid this "shadow' effect, the distance between the buildings has to be at least east six times the height of the first obstructing volume.

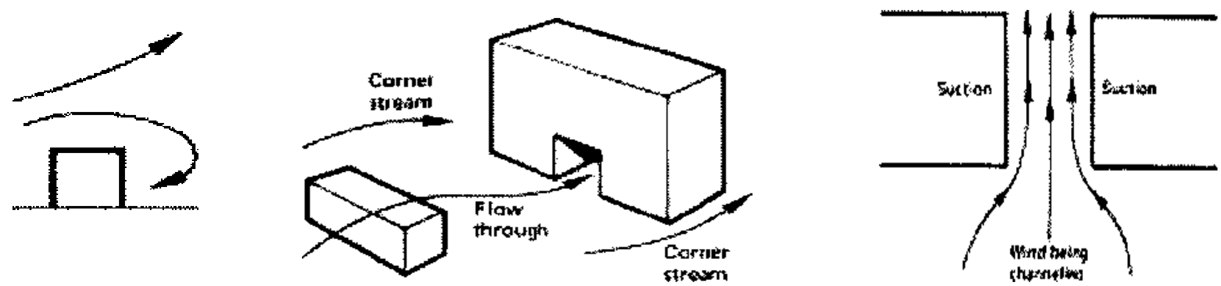


Figure 2.3: Wind Flow and Shadow Effect Between Buildings.

Source: Bittencourt 1993

Effects of vegetation

The microclimate of the site can be greatly affected by the type of the surrounding vegetation. A large forest or a densely planted zone produces a relatively small wind wake area, the re-circulation region immediately after the obstruction containing low velocity eddies, in relation to its size, *(Figure 2.4).* A short and high line of trees on the other hand can produce a relatively large wake size acting as a windbreak.

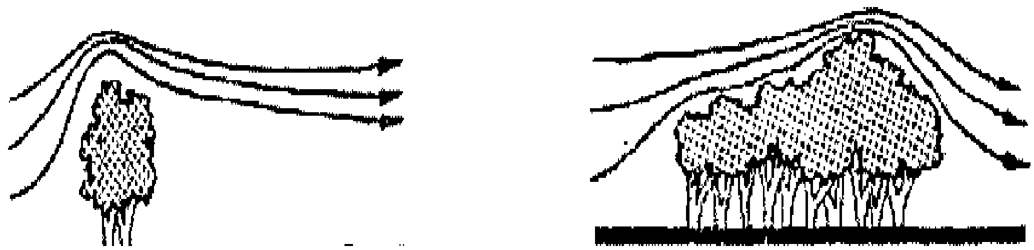


Figure 2.4: Effect of Vegetation on Wind Pattern.

Sourse: Bittencout, 1987

The density of tree foliage and the presence of lawn or shrubs under a group of trees may also generate distinct flow patterns. For a line of trees with foliage starting at about 1.5m from the ground, the wind flow rates may be reduced by 30% to 50% depending on the distance between the individual trees. But for trees with high foliage that are planted well apart from each other and the wind can flow underneath and between the trees, the distance from the building is not significant for ventilation purposes. In tropical regions coconut and palm trees can produce shading with a minimum impediment to wind flow (Bittencout 1993).

Ventilation within buildings

The design requirements of the individual spaces should determine whether an even distribution or concentrated jets of air are the most appropriate for ventilation purposes. In a school environment, an even distribution is likely to be more adequate for spaces such as halls or lecture areas where flexibility in their functions may be a design consideration and where draughts or zones of still air are undesirable. Whereas concentrated jets with higher speeds might be more appropriate for spaces such as computer rooms where the occupants are induced to remain in a fixed location.

The main factors affecting the pattern of airflow entering a building are the size and shape of the inlet apertures, the location of the openings, the type and configuration of the inlets and the configuration of other adjacent elements such as internal partitions, projections and vegetation.

Opening size and shape

Bittencourt has carried out a thorough investigation into natural ventilation of low-rise buildings (up to three storeys') in warm-humid climates; much of the following is based on that research. Average internal air speeds are represented as a percentage of the external wind speed.

Opening sizes and shape are important factors that determine the airflow within buildings. For buildings with openings in opposite walls, improved ventilation rate can normally be achieved by an angular wind incidence to the inlet. In this situation, greater airflow rates are also usually achieved when the outlet is larger than the inlet opening. But whereas the reverse is also true, air speed is more evenly distributed around the space when the outlet is smaller than the inlet. This is because part of the kinetic energy is converted to static pressure around the leeward opening.

When the inlet and outlet are of the same size, the internal air speed is related to the porosity of the building envelope irrespective of the angle of incidence of the wind. For instance, a building with 40% porosity causes an average indoor wind speed nearly twice that of a building with 15% porosity (Bittencourt 1993).

The shape and configuration of the opening also have an effect on the internal wind speeds. For a given opening size, horizontally, square and vertically shaped inlet openings yield different internal air motions. Horizontally shaped inlets provide much higher internal air speeds than square or vertical inlets for all wind angles; the optimum performance for horizontal inlets is achieved when the wind incidence angles are directed at around 45° to either side of the perpendicular. Rectangular openings also provide a more\evenly distributed internal airflow. The introduction of vertical louvres alters the performance of horizontally shaped inlets as a function of the wind and louvre angles.

Opening Location

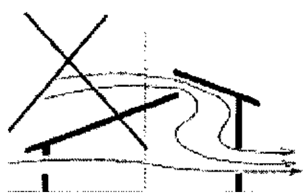
Cross-ventilation is optimum in rooms with openings in three different facades but such configurations are not common (*Bittencourt 1993*). For rooms with openings in two adjacent walls, higher average air speeds are achieved when the angle of the wind is perpendicular to the inlet for most configurations, as opposed to inclined wind incidences.

In buildings with intermediate openings, the internal air-distribution is mostly determined by the total area of the openings in the walls with the smallest area of openings. This may be an important consideration in the planning of multi-zone spaces such as entrance lobbies of buildings.

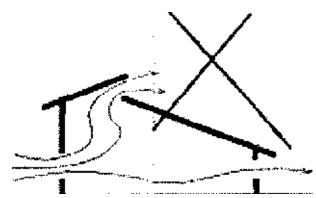
Ventilation openings can also be placed in the roof or above in the form of clerestory windows, ridge projections or wind-catchers. Wind velocities above the roof level are much greater than at wall level and those devices potentially act either as air inlets or as extractors, depending on the wind direction. This strategy is particularly advantageous in densely built areas, as such projections have significantly smaller volumes than the building below and so they are less likely to become obstructed by adjacent developments.

The effectiveness of clerestory opening in roofs as a ventilation device has been tested in wind tunnels (Gandemer et al 1992), and has shown that the clerestory area needs to be at least 20% of the cross-sectional area of the building perpendicular to the window direction. When clerestory openings are properly designed, the improvement in average indoor air speeds for cross-ventilated rooms can be as high as 40% for openings acting as exhausts and 15% when functioning as inlets. *Figs. 2.5a and b* indicate the incorrect positioning of clerestory openings relative to the building's central axis.

The best position for clerestory openings acting as inlets is in the upwind section of the roof and in the downwind for exhausts.



a



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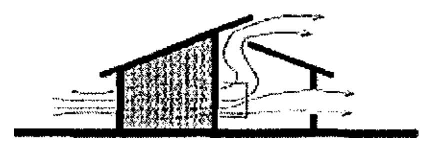

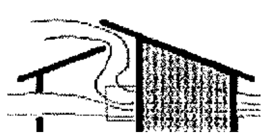

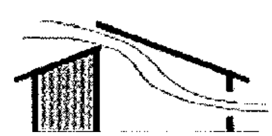

Figure 2.5: Effect of Clerestory on Average Internal Airflow Rates

Source: Gandemer et al, 1992

Wind-catchers have been successfully employed in several regions in the Middle-East and Africa. In a faculty building, the introduction of roof ventilation could be a particularly useful strategy also for deep-plan spaces where flow rates provided by wall openings alone may not suffice.

Opening types

Apart from the environmental considerations, daylight, ventilation, protection from the rain, type of materials and embedded energy; the choice of the opening type is also determined by other equally important factors such as the function of the space, aesthetics, operability, views, cost, availability, security and privacy.

From the ventilation point of view, the most adequate types of openings for warm climates are those with a high degree of porosity, about 50%. Desirable typologies of windows include louvres, jalousies and horizontally pivoted sash windows, particularly if they also incorporate louvres that incline as a function of the sash position. Adjustable horizontal louvres are especially beneficial as they allow for greater control of the direction of airflow inside the room, *Fig. 2.6.*

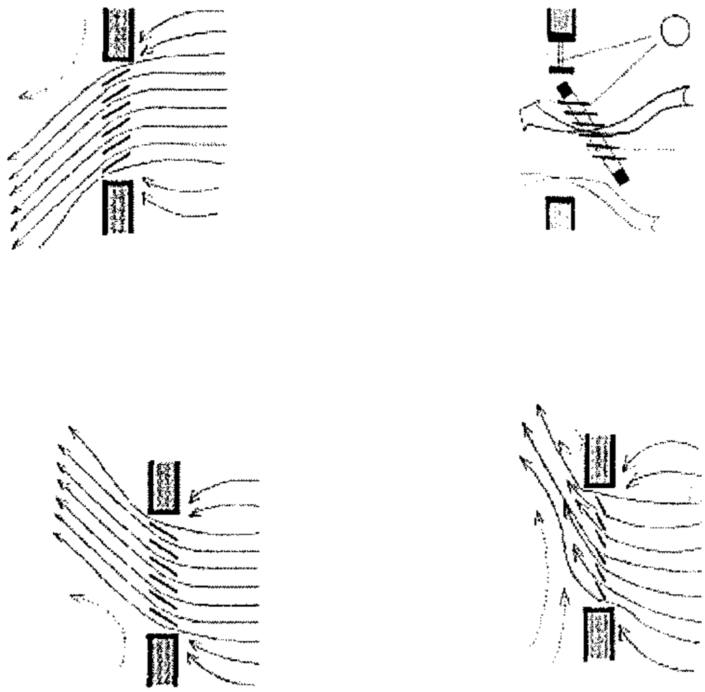

Figure 2.6: Adjustable louvers and projecting windows with fixes louvers.

Source: Gandemer et al, 1992

Louvred openings can also be used in conjunction with other elements such as high-level shading projections and perforated blocks to increase the airflow within the rooms.

Vertical and horizontal projections

The introduction of vertical projections such as external wing-walls or internal partitions causes alterations to the internal airflow rates as they increase or decrease the pressure difference between inlets and outlets. The efficiency of external projections depends on their sizes and positions relative to the prevailing wind. External projections can act as vertical wind-catchers and enhance the internal ventilation rates in both cases of skewed and perpendicular winds, but when incorrectly used can have the opposite effect, acting as windbreaks. *Fig. 2.7b and c* show the undesirable effects of external projections.

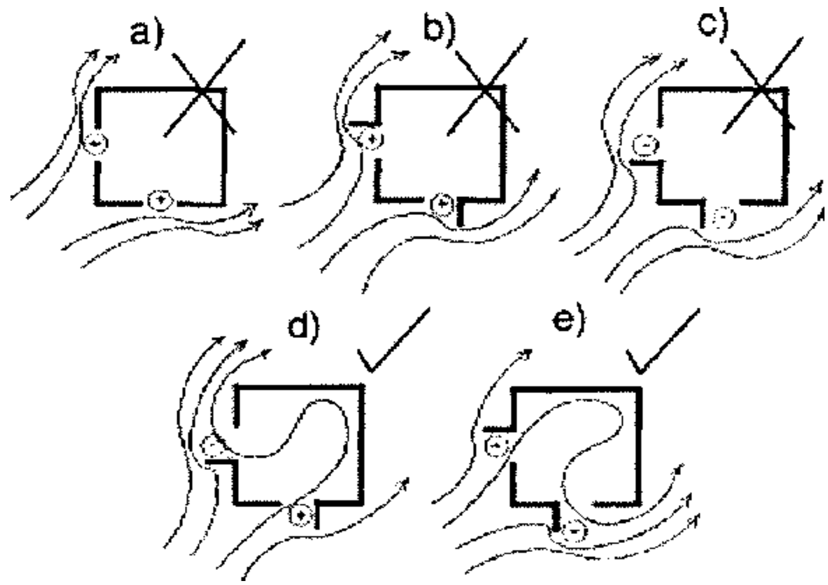

Figure 2.7: Effect of wing walls on cross ventilation.

Source: Gandemer et al, 1992

In altering the pressure build-up around the inlet, vertical projections can be employed to modify the internal flow pattern and force the air stream into different directions. Vertical projections are especially useful for single-sided ventilation in space with more than two openings, particularly if the wind is from a skewed angle.

In addition to their shading properties, horizontal projections such as overhangs, canopies and verandas can also be used to modify air patterns internally as they can deflect the wind streams that would flow above the building to the inside.

Figure 2.8: Horizontal projections and airflow patterns

Source: Olgyay, 1963 and Bittencourt, 1993

When placed immediately above the opening, the horizontal projection eliminates the downward element of the wind at the inlet and pushes the air stream towards the ceiling. Air circulation above head height is of little use for the purpose of physical cooling of the occupants in living spaces, but this may be a relevant condition in spaces such as toilets where air-extraction at high level is desirable. The introduction of a gap between the projection and the wall will tend to reinstate the original course of flow, as it recovers the downward component of the pressure at the top of the inlet opening.

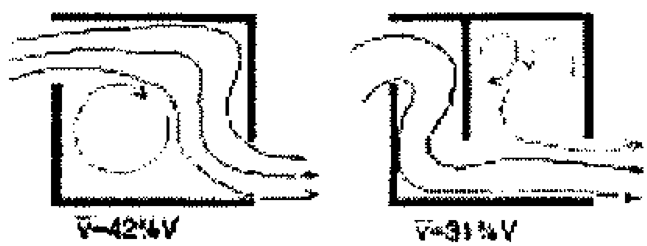

Figure 2.9: Internal partitions and airflow patterns.
Source: Givoni, 1976

2.6.4.2 Climate and design strategies

The three main possibilities for climate modification are passive, active and hybrid cooling. In the passive system there is no mechanical plant or equipment, it relies on natural energy and at best the internal temperatures match those of the external shaded areas. The known problem with this model is when there is incidence of high casual gains that increase the environmental loads. A totally passive system in a faculty building situation would therefore have to take into consideration the microclimate, building form and fabric as climate modifiers as well as guests' expectancy of level of acceptable thermal comfort, which may have commercial implications. The active system on the other hand uses artificial energy. It provides an almost totally controlled internal environment and it requires the planning of service plants from the initial design stages, regular maintenance and often presents problems of localised heat gains from environmental loads. The third, hybrid system, as the name suggests, uses a combination of both passive and active systems. It requires equipment and/or plants to cool the heat from the environment and casual gains and it uses the natural microclimate and the building fabric as climate modifiers. Facilities management and/or a computerised system need to be employed to control diurnal and seasonal climatic variations to make this system energy efficient.

As we have seen through Givoni's chart for Recife, the indications are that ventilation alone may provide sufficient cooling during most of the year. The microclimate of the site will an also play important role in the implentatimeon of a passive cooling svstem.

Next, we look at some of the known passive strategies for hot and humid climates as suggested by Richard Hyde and Armando de Holanda" followed by comments on their applicability to the school typology in Recife. Although much of the following is suggested for use in domestic buildings, most of these principles would seem to apply also to non-domestic schemes.

Climate:

I. Minimise heat gain, maximise ventilation and shading.

Plan:

I. Thin and unobstructed plan for cross ventilation and avoidance of dark areas internally

II. Large windows and doors facing the direction of the wind (mostly SE in the case of Recife with some kind of control for the reason mentioned above). As a general rule, the sizes of the exhaust windows should be at least equal to those of the inlet windows.

III. Screens to openings to protect against insects if applicable.

IV. Courtyards for deep plan buildings with diffuse lighting to reduce glare. Raised floors to encourage airflow below the building. In humid climates, this strategy is also used for guarding against decay of floor structures and it is particularly useful for maintaining a dry interior in coastal areas subject to floods.

V. Breezeways to provide open circulation between spaces.

Section:

I. Open section with high ceilings to maximise stack ventilation.

II. Large overhangs to protect walls against solar radiation (this has to be carefully balanced against the amount of natural light required internally).

Landscape:

I. Trees for shading and planting, creepers, etc on verandas to disperse heat and glare. (The range of local species of planting available is plentiful and the scheme should involve the careful selection of appropriate trees and planting. Landscaping should be seen as an integral part of the project, vegetation used strategically as much as possible to provide shade and reduce the temperature of the ground and external fabric. The use of tree leaves as low emissivity shields to absorb short-wave solar radiation and reduce the temperature of the microclimate.)

Materials:

I. Lightweight materials for quick response and cooling at night.

II. Parasol type of roof to increase ventilation with light colour externally and on ceiling, with reflective foil laminate within the roof construction to reflect solar radiation, minimising the area on ceiling for artificial lighting. (Other types of roof construction such as double roof with a ventilated gap or attic are also applicable),

III. Insulated ceiling,

IV. Reflecting foil laminate within walls to reduce the infiltration of radiation,

2.6.5 High Thermal Mass

This depends on the ability of materials in the building to absorb heat during the day. Each night the mass releases heat, making it ready to absorb heat again the next day. To be effective, thermal mass must be exposed to the living spaces. Public buildings are considered to have average mass when the exposed mass area is equal to the floor area. So, for every square foot of floor area there is one square foot of exposed thermal mass. A slab floor would be an easy way to accomplish this in a design. High mass buildings would have up to three square feet of exposed mass for each square foot of floor area. Large masonry fireplaces and interior brick walls are two ways to incorporate high mass. Concrete, stone, or other massive and dense construction creates a potential to absorb heat. Some methods in use include Trombe Wall (usually used for heating, but equally effective at cooling), water containers, exposed concrete slabs. The effectiveness of this method can easily be experienced, on the next hot day, go lay down on a concrete floor that isn't directly in the sunlight, the mass will be so cool. High mass systems can be used in concert with ventilation, particularly night ventilation, to cool in regions that reach temperatures s high as 110 degrees and are relatively dry, but are not very useful when the relative humidity exceeds 60%.

2.6.6 High Thermal Mass With Night Ventilation

Relies on the daily heat storage of thermal mass combined with night ventilation that cools the mass. The building must be closed during the day and opened at night to flush the heat away.

2.6.7 Evaporative Cooling

Everyone readily recognizes how nice it is to feel a spray of cool water on a hot day. But did you know that water can actually decrease the sensible temperature of the air? The principle is to allow water to evaporate at the top of a tower, either by using evaporative cooling pads or by spraying water. Evaporation cools the incoming air, causing a downdraft of cool air that will bring down the temperature inside the building. The effectiveness of this method is restricted to hot dry climates.

2.6.8 Select Energy-Efficient Appliances

The first step in minimizing heat generated within the home is choosing energy-efficient appliances throughout the house, from the large appliances like refrigerators down to the smaller ones, like light bulbs. The less efficient an appliance is, the more waste heat it generates: thus, its inefficiency costs in two ways: the extra energy it costs to run the appliance, and the cooling penalty that comes with having to remove the extra heat it generates.

Most major appliances come with energy-guide labels that show how much energy the appliance will use, and compare its energy use to that of similar products. Use these labels to guide your purchases. Remember that you will continue paying for the appliance long after its purchase due to the energy it consumes, so that the one that appears least expensive at first may not be so in the long run.

In general, incandescent light bulbs are the least energy efficient source of lighting for the home. Better alternatives include fluorescent lights and day lighting. If there are windows in the home, and if they have been shaded with trees, overhangs, awnings, or venetian blinds as discussed in the previous section, day lighting can be an effective source of diffuse sunlight. Diffuse light entering from the side is a pleasant and effective source of lighting for the house during the day. Direct sunlight tends to cause problems with glare and introduces too much heat along with it to be a sensible source of summer lighting. Skylights are generally not considered an energy saving source of day lighting because of the increase in the houses cooling load caused by the heat that they admit.

2.6.9 Use Appliances Wisely

Kitchen and laundry appliances, by design, produce heat. By substituting less-heating alternatives or scheduling their use for the cooler morning or evening hours, however, their effect on the houses load can be minimized. In the kitchen, use a microwave oven or a smaller toaster oven rather than the large oven whenever possible. Serving y less than half,

2.7 DEDUCTION

The diagrams exemplified here are usually used to obtain the external pressures to each side of the building. This is done by the assignment of regions coinciding with elements such as walls, windows, roofs and floors, should they be elevated from the ground.

Planning for the integration of the ideas outlined in this paper will make it possible to reduce dependency on finite energy sources by designing a faculty that will consume minimal amount of electrical energy for it running. The use of passive cooling techniques, materials, and access laws can help create a built environment that will make a sustainable lifestyle possible. Proper orientation to the sun is essential for effective performance.

CHAPTER THREE

MATERIALS AND METHOD

3.1 THE STUDY AREA

The general philosophy of the Ibrahim Badamasi Babangida University, Lapai (IBBU), is to create a learning environment that would harness the capabilities of students and capacities for an effective utilization of their intellectual and creative endowments to be channelled into the human and material resource base of the state in particular and the nation at large. It is also to cater for the ever expanding desire of the people of the State for acquisition of higher level knowledge. The University would, therefore, amongst other functions, seek to meet the high level manpower needs of Niger State on the basis of an expounded philosophy of promoting learning for human development and a knowledge based-economy.

3.2 RESEARCH METHOD

It is the logic that links the data to be collected to the initial questions of a study (Yin 1994). The study aims to design a structure that has minimal solar heat penetration which will enhance student's ability to interact, learn, and solve problems using modern computational tools and techniques. This calls for combination of research methods in order to understand the techniques and principles in ensuring the comfort of the users. Both quantitative and qualitative methods of research will be used.

3.2.1 Methods of Data Collection

The study of passive cooling is complex and entails studying comfort of individuals. This can be achieved using various sources of information on passive cooling in buildings by reviewing past literature, interviews, observations and survey. This allows an investigator to address a broad range of issues (Yin 1994).

3.3 CASE STUDIES

The purpose of this chapter is to present the case studies carried out, which include three ICT building. The case studies are ICT building in Federal University of Technology minna, Faculty of Information Technology Senlangor,` Malaysia, and Faculty of Information and Communication Science, University of Ilorin. The importance of these case studies is to have an understanding of the basic requirements of a faculty building and to make a thorough appraisal in relation to it merits and demerits. This will in turn serve as a guide for the new proposal that will be made.

3.3.1 CASE STUDY ONE: ICT CENTRE, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

Information and communication technology centre is located in Federal University of Technology Minna. It comprises of an ICT building and lecture theatre. The main building comprises at the ground floor; offices, reception and convenience, and at the first floor; offices, conference room, directors office and convenience.

Plate V : Showing the Rear and Side View of the Building

source: Field work 2011

i. MERITS

The building is well located, in proximity with other faculties. It has proper orientation, so as to require a minimal amount of energy to maintain the thermal balance needed for effective performance of the building and its inhabitants. It has a shading device to prevent the effect of heat infiltration into the building.

Plate VI : Showing the Approach of the Building having Shading Devices.

Source: Field work 2011

ii. DEMERITS

The internal spaces in the building are not properly ventilated, due to the presence of one opening serving as windows. This brings about the need to use mostly mechanical means of ventilating the building to provide thermal comfort.

Plate VII: Showing the Corridor with Inadequate Lighting and Ventilation

Source: Field work 2011

3.3.2 CASE STUDY TWO: FACULTY OF INFORMATION AND COMMUNICATION SCIENCES, UNIVERSITY OF ILORIN

Faculty of information and communication sciences is located at university of Ilorin in Kwara state. The faculty was created to cater for the rising need of information and communication awareness in the world. The department consists of an administrative building, two blocks having 100 computers each with offices and a block having 50 computers.

Plate VIII: Showing the Building in Relation to Site Planning

Source: Field work 2011

i. MERITS

The building is well located, in proximity with other faculties. It has proper orientation, requiring a minimal amount of energy to maintain the thermal balance needed for effective performance of the building and its inhabitants. It is properly planned and has an adequate soft and hard landscape, which serves as an advantage in reducing the use of artificial means of ventilations.

Plate IX: Showing Corridor of the Faculty

Source: Field work 2011

ii. DEMERITS

Some of the internal spaces in the building are not properly ventilated, due to the sizes of windows in the building. This brings about the need to use mostly mechanical means of ventilating the building to provide thermal comfort. The provision of element that provide passive cooling are inadequate.

Plate X: Showing the Right Side View of the Faculty

Source: Field work 2011

3.3.3 CASE STUDY THREE: FACULTY OF INFORMATION TECHNOLOGY, SENLANGOR MALASYIA

The faculty is located in Senlangor in Malasyia. The faculty was created to cater for the rising need of information and communication awareness in the world. The faculty consist of an administrative building, computer halls, lecture theatre, offices with different laboratories.

i. APPRAISAL

There is a good use of materials in constructing the buildings. There is adequate number and sizes of windows. The buildings are properly oriented to allow for a good flow of natural air in and around the building, thereby maintaining thermal heat gain and heat losses in the building. The size of the courtyard is not sufficient. This will give room for heat to be trapped in the corridor.

Plate XI : Showing the Courtyard of the Faculty

Source: Field work 2011

Plate XII : Showing the Rear View of the Faculty

Source: Field work 2011

Plate XIII: Showing the Faculty and the Relationship to Site

Source: Field work 2011

3.4 DATA COLLECTION

Data collection is a requirement of every research work. This is because it gives the required information for the project by giving an insight and perspective to the project at hand.

3.5 SITE ANALYSIS

The selection of the site was done through a careful analysis, based on the standard criteria. Accordingly, the criteria considered in the selection of the site are as follows:

i. Availability of well drained flat land suitable for the needs and functions of the faculty and adequate area for its future expansion,

ii. geological, soil and topographical considerations that promote institutional development,

iii. availability of facilities, services and utilities in the university ,

iv. minimal displacement of existing buildings ,villages, and farms,

v. the relationship of site to other faculties in the university,

vi. Site potentials for generation of traffic and congestion,

vii. potentials for the developments of surface water supply scheme

3.5.1 The Site

The faculty will be sited in-side the university on 0.12 hectares of land acquired by Niger State Government, along Paiko and Lapai Road, some three kilometres from the town of Lapai.

Plate XIV: MAP OF NIGERIA

Source: IBBU Master plan

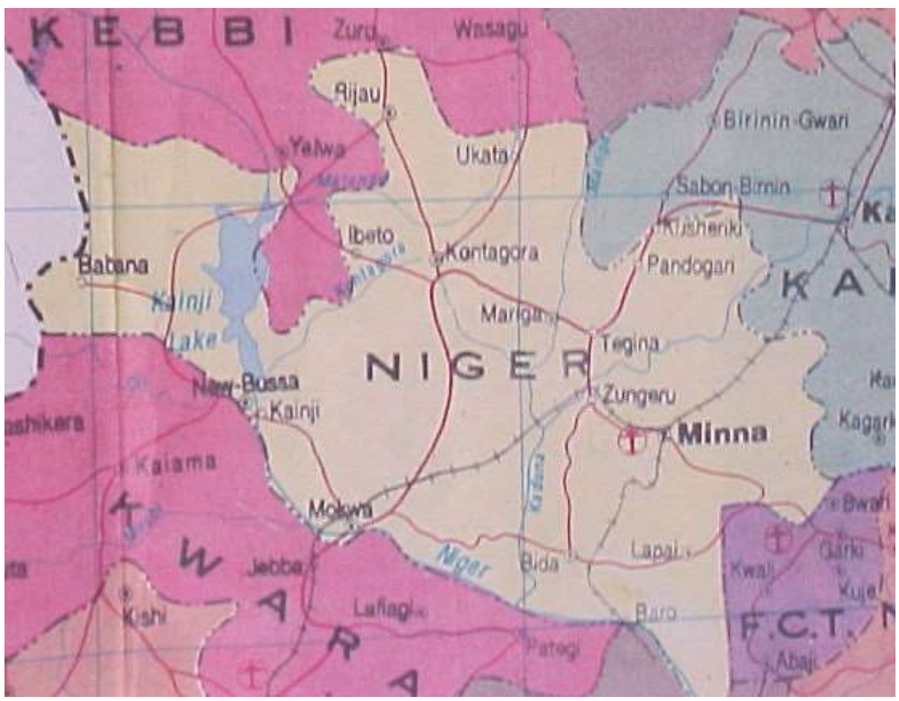

Plate XV: MAP OF NIGER STATE

Source: IBBU Master Plan

3.5.2 Geographical location

Lapai is about 74km from Minna, 69km to Bida. The IBB university of which the faculty will be sited is geographically located on latitude 9º03'17. 60" - 9º05'07. 22" and longitudes 6º33'49. 53"- 6º35'38. 47". It is bounded on the east by an un-tarred road that leads from Lapai to Mikugi and on the west by the tarred road leading from Paiko to Lapai (Figure 3.1).

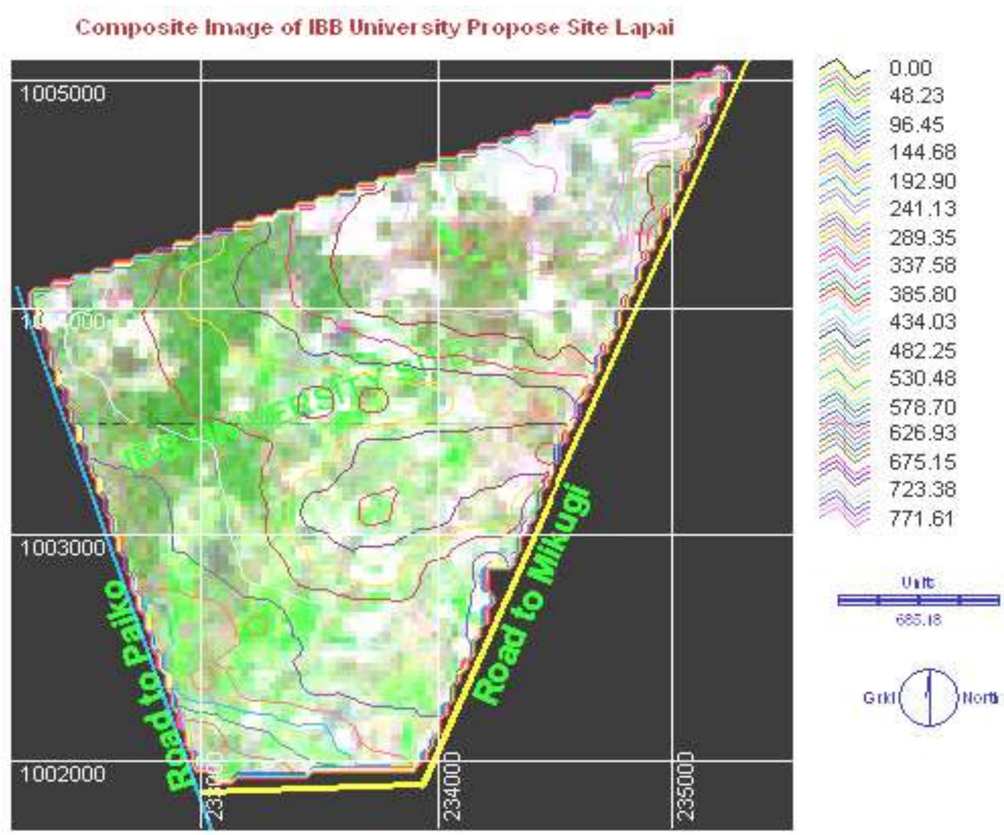

Plate XVI: The Site Boundary

SOURCE: IBBU Master Plan

3.5.3 Existing Land Use Pattern

The site is located in a sparsely settled farm area in the University. The site has been in active use as a farmland with cassava, and cashew as the dominant crops. Within the site there is no evidence of any settlement or structure.

3.5.4 Site Climate;

The climate of the site, just like that of other parst of the region, is influenced by two dominant trade winds; the North East trade wind and South West trade winds. These two wind systems determine the entire climate.

The rainfall in the area begins as from March/April when the South-west wind from the ocean pushes north, while the North East winds bring with it the dry season as from November. The setting in of the rainy season is usually characterized by strong winds and thunderstorms, which usually result in destruction of property and sometimes lives. It is therefore necessary to put into consideration the wind direction in the layout of buildings within the Campus. The dry season is characterized by the dry dust laden harmattan winds coming from the dry Sahara area. This occurs between November and February during which the relative humidity is low.

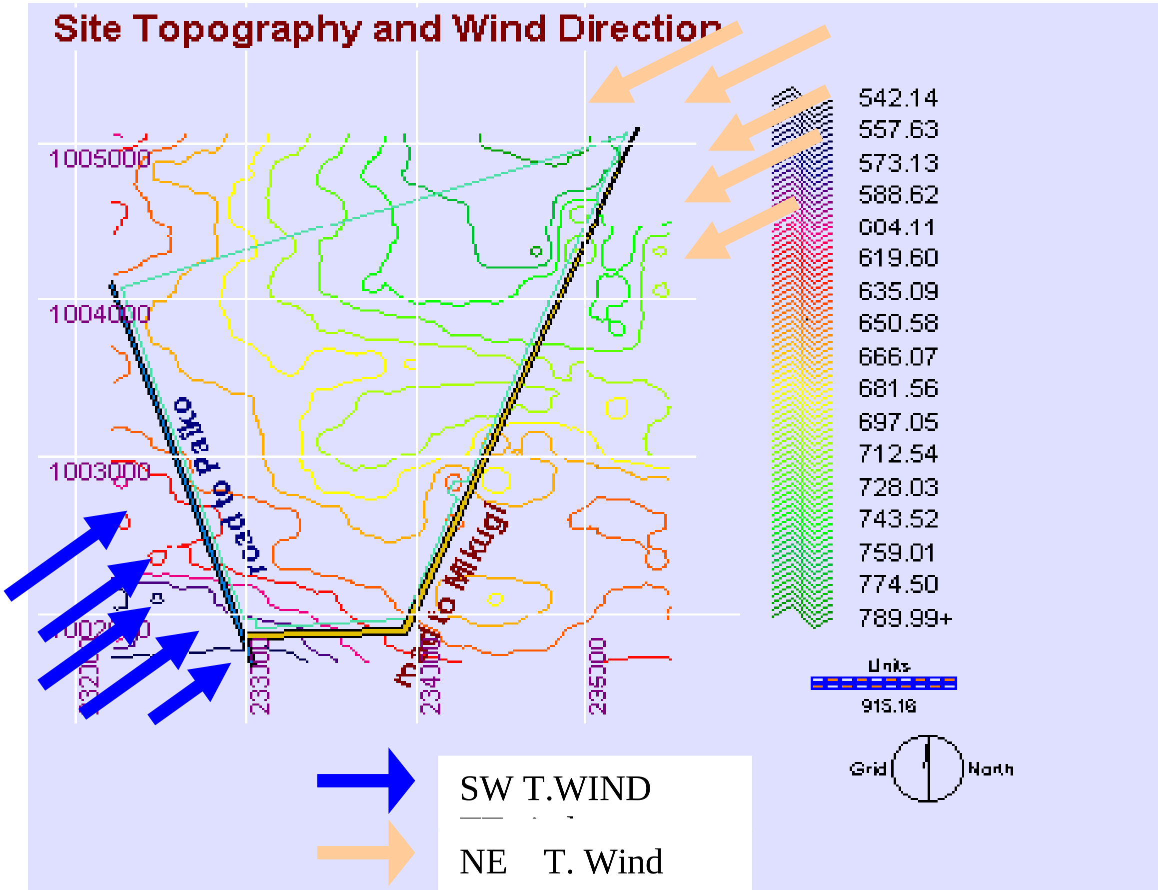

Plate XVII: Site Topography and Wind Direction

Source: IBBU Master Plan

3.5.5 Temperature

The average temperature of the area is about 29.8^{0}C.The months of February-May are generally the hottest periods with an average temperature of about 30^0 C. The months of March and April have the highest temperatures of 31.1^0 C and 30.4^0 C respectively.

3.5.6 Vegetation, Flora And Fauna

The site lies within the guinea savannah vegetation belt. The vegetation zone is a by-product of centuries of tree destruction by man, animals and weather. In the processes of adaptation, the trees have developed a long and extensive root systems and thick bark to enable them survive the long dry season and annual bush fire.

The dominant tree and shrub species are mainly,

1-Tree- prosopis Africana, Anacadium occcidentale, Mangifera indica, isoberlia Doka, Ficus spp, Butryospermum Parkii, adansonia Digitata, Balanites Aegyptiaca, Parkia biglobosa, Acacia spp, afzelia spp.

2- Shrub- Poliostigma reticulum latifolia, Nucleau Danchrostachy cinera, Deutarium Macrocrpum, Ziziphus Mauritiaca.

3.5.7 Soils.

The soils of the site are heterogenious in nature. Their heterogeneity falls between sandy clay loam, sandy loam and sandy. While in some profiles, sub horizons are clayey in nature. The drainage of all the soils segmented are rapid in nature, this is as a result of the texture, soil depth and the relief of the environment, meaning water entry into the soil is fast, percolating down the strata or horizon of the soil.

The soils are fertile and productive as shown in the result of the physicochemical analysis. The soil survey conducted took samples from 20 pits scattered over the university site. Samples from each of the sites were analyzed to determine the composition and bearing capacity. This information is needed during physical development.

3.5.8 Existing Facilities/Services And Utilities In and Around the Site

Lapai has the following facilities that can be easily accessible to the university community.

3.5.8.1 Market

Lapai has a weekly market that operates on every Tuesday and is located about 2km to the university. The town also has several shops and supermarkets.

3.5.8.2 Electricity

The town's electricity is serviced by Doko feeder (33kva) supply by NEPA. This will soon be augmented by a feeder from Minna which is also 33kva capacity. Though the 33kva is adequate there is no stable power supply to Lapai.

3.5.8.3 Water

The water supply is from the Niger State Water Board system in the town. The capacity of the system is about $1000m^3$, but the existing plant hardly produces up $77m^3$ daily. This quantity is grossly inadequate for the present population of the town; in fact even the $1000m^3$ is inadequate for the town.

Presently the supply from the Water Board is augmented with water from the university water works which is 120000liters capacity, boreholes, which have to be up to 70-80m deep to make them effective. Most of the rivers are seasonal and this explains why most of the communities around the university depend on boreholes.

3.5.8.4 Telecommunication

The existing networks present in the town are Glo, Mtn, Airtel. Etisalat network is presently mounting its mast for the provision of mobile telecommunication services.

Postal and well rendered internet services are available.

3.5.8.5 Health Service

The community clinic/hospital is less than 1 kilometre from the University gate. It would, however, require up grading in view of the improved status of the town with the coming of the university.

3.5.8.6 Displacement of Existing Settlements, Buildings or Farms.

The location of the university will not lead to the displacement of any community or buildings. The land is generally occupied by farmlands.

3.5.9 Existing Land Use of The Site.

The site is not close to any military or police establishment. The site is not close to any manufacturing industry. The university is about 80km to Federal University of Technology and College of Education in Minna and about 69km to Federal Polytechnic Bida. There is no airport or rail station within Lapai that may generate noise to affect the learning condition. However the site being close to the major road from Paiko/Minna can be affected by the traffic. The site might have potential for generation of traffic congestion along the road and Abuja/Lapai road.

3.6 Importance of Climatic Study in Design

Climate has a major effect on building performance and energy consumption. The process of identifying, understanding and controlling climatic influences on the building site is perhaps the most critical part of building design. The key objectives of climatic study in design include: To reduce energy cost of a building; to use "natural energy" instead of mechanical system and power; to provide comfortable and healthy environment for all users of the building. For this reason, climatic study of the area intended for the proposed design cannot be overlooked. This will avoid severe consequences after the execution of project.

3.7 DEDUCTIONS

A lot of positive and negative observations were made after a critical analysis of the various case studies. It was observed that all the cases studied have a proper orientation, and requiring a minimal amount of energy to maintain the thermal balance needed for effective performance of the building and its inhabitants.

Despite all the merits observed, some shortcomings were also observed. In all the cases studied, provision of element that provide passive cooling is inadequate. Their premises were not well landscaped and they all lack adequate parking spaces.

In conclusion, lots of improvements need to be made on the proposed design as a result of the observations made. The merits will be improved on and the demerits will be elim

CHAPTER FOUR

PRESENTATION OF DATA AND DISCUSSION

Table 4.1 FACULTY DEAN'S UNIT

SPACE	TOTAL AREA PER M^2
Dean's office	19.44
Dean' secretary office & waiting area	13.86
Dean's toilet	1.80
Deputy dean's office	15.12
Deputy dean's toilet	1.80
Faculty officer 's office	12.60
Faculty board room	96.00
Faculty exam office	17.64
Faculty I.T Room & cafe	96.00
store	13.86

Table 4.2 DEPARTMENTAL UNIT

SPACE	TOTAL AREA PER M^2
H.O.D's office	24.88
H.O.D's toilet	1.80
H.O.D's secretary	16.20
Professor's office	17.82
Professor's toilet	1.80
Associate professor's office	17.82
Senior lecturer' office	17.82
Lecturer I & II office	17.82
Assistant lecturer office	17.82
Departmental exam office	14.85
Departmental board room	40.50
Departmental library	40.50
Departmental toilets	27.82
Departmental lecture room A	72.00
Departmental lecture room B	36.00
Departmental laboratory A	72.00
Departmental laboratory B	36.00
Departmental store	13.86
Departmental Data room	24.30

Table 4. 3 COMMUNICATION UNIT

SPACE	TOTAL AREA PER M^2
Studio 1	150.00
Studio 2	150.00
Lecture room 1	150.00
Laboratory 1	150.00
Lecture room 2	60.00
Laboratory 2	60.00
office	38.88
store	8.10
Convenience	17.28

Table 4.4 LECTURE THREATER

SPACE	TOTAL AREA PER M^2
Office 1	22.68
Office 2	22.68
Projector room	7.29
Female changing room	8.10
Toilet & shower	3.15
Male changing room	8.10
Toilet & shower	3.15
Lecture Hall	493.70
Convenience	20.16

4.1 PLANNING PRINCIPLE, CONCEPT AND CONSIDERATION

Before embarking on the design on the preferred site, it is logical to briefly review the principles and concept used in the design.

4.1.1 PRINCIPLES

In planning any design, the goal is to satisfy the intended occupants, and achieve environmental integration. Students satisfaction should be the major consideration. Students consciously or unconsciously have a number of requirements.

(a) Reacting in tranquility with facilities for learning.

(b) Anonymity but also the opportunity to interact with other people and participate in other social activities.

How They Can Be Achieved:

Tranquillity, seclusion and privacy can be achieved by zoning activity areas away from quiet zones. Noise from traffic can be controlled by centralizing parking spaces at convenient locations instead of allowing free flow into the faculty.

Interaction between students can be achieved in the lecture rooms and studios created.

4.2 DESIGN CONCEPTS AND CHARACTERISTICS

In the design of buildings there are different concepts which are adopted for the purpose of conceiving a design. These are the metaphorical, analogical and canonic concept. The one used in this design is canonic in nature which is also logical. It involves the bringing together of several independent units in one place, so as to create a better environment by effecting proper environmental control and provide students with easy access to various units in the area. It also helps to create a learning atmosphere located together in which students will receive an enhanced environmental, social and corporate performance towards effective global learning competitiveness. Each unit was designed such that it can operate independently. The site arrangement as a whole is based on the relationship of various units of the faculty and safety consideration of activities carried out in the various units. Proper orientation of the various units determines the final arrangement of the facilities on site. The arrangement of the units on the site was influenced by the direction of the sun and to avoid the penetration of sunlight into the building, the shorter side of the building was made to face the east direction. This was easy to achieve as the site is inclined.

4.3 DESIGN

The design is based on human psychology and the need to achieve a balance between functionality, aesthetics, form and sanitation. And to design an ICT building that will not only cater to students, but also be a place that will promote effective learning and research. Design fundamentally produces a plan, guideline and models that present the characteristic of the structure to be constructed. In design of an ICT building, selection and combination of shapes and colours to form a successful functional faculty depend on the human psychology, climatic control, and aesthetics. In-lieu of this, a simple plan was developed, after careful case studies and research. A circular shape and courtyard for effective ventilation was adopted in all the building structures.

The other buildings on the site are also designed in symmetry, to maintain balance and represent balance that nature always stands for. A beautiful and eco-friendly landscape has also been designed to make the faculty friendly for the tutors and their students. Careful consideration has seen given to the circulation and connections of each of the facilities to one another, in order to achieve comfort for the staff carrying out their duties and that students may find it easy to move from one unit to another.

4.3.1 SITE ZONING AND PLANNING

The site zoning is done in such a way that the objectives of the design are achieved. The zoning takes the following into consideration.

- The effective and efficient interaction of the facilities
- The quite, semi quite facilities

- And overall landscaping of the faculty to have a conducive environment for learning.

The planning of the road, walkways, drainage and landscaping are done based on the deductions made from the site inventory (site analysis).

4.4 MATERIALS AND CONSTRUCTION

Materials and construction include the finishes and construction method used in the building. To ensure proper stability and functionality of the proposed design, the materials and construction method used were carefully chosen after due consideration given to the cost, durability, availability, aesthetics, maintenance of the material and the appropriate methods of construction.

4.4.1 MATERIALS

In order to achieve good construction, the choice of material should be a vital decision of a designer; the chosen material should be the best option, sound in quality, affordable and aesthetically pleasing.

The choice of materials for the faculty has been given proper consideration, particularly to the type of dominant climatic condition of the site and the availability of the materials is also paramount in the decision to use them. This has ensured the durability, functionality, and aesthetically pleasing of the facilities in the site.

Distinct properties of strength, stiffness, elastically, density, hardness and resistance to wearing which characterize building materials are manifested by physical or chemical process. Good materials are those, whose elasticity and stiffness are in the right proportion. Also economic considerations have to be made for the maintenance, cost and durability. Amongst other considerations is the standard size in which some building materials are manufactured so as to avoid wastage during construction. Also the method of fastening and finishing materials has to be considered, keeping in mind the various functions that building shall be put into. Some of the basic materials employed in the design and construction of this project are briefly discussed below.

a. Concrete

Concrete is a mixture of sand, gravel or other aggregates held together by hardened binding agent (cement and water). The mixture, when properly mixed proportionally, is at first a plastic mass that can be cast or moulded into a predetermined size and shape. Concrete becomes stone like in strength, hardness and durability upon dehydration. Concrete is infinitely strong in compression, to handle tensile forces, it has to reinforced with steel reinforcement. It can be formed into any shape with a variety of surface finishes texture and patterns. Concrete provides good fireproof construction. It is used basically in this design for floors, slabs, gutters, columns and beams as well as roofing and retaining walls

Concrete is produced in basically two forms, precast and insitu cast concrete.

Precast concrete: This is the concrete produced outside the construction site and then transported to where it's to be used after it has set.

Insitu cast concrete: Insitu cast concrete is produced there and then on site where it is to be used so that it sets in its place.

b. Masonry

These are man – made units, formed and hardened into modular building unit's, for example; tiles, blocks and bricks. They are laid up in such a way as to enable the entire masonry mass to act as an entity, because of their relatively weak nature and of the mortar that bonds them together.

Masonry is structurally effective in compression. This is graded according to the compressive strength. The mortars, which bind the units together, are also graded according to compressive strength and use.

The appearance desired is one of the factors to be considered in the choice of the type of masonry unit. The climate dominant on the site is also a major consideration in the choice of type and size of the masonry units for the design and construction. In the design of this faculty all external walls are designed to be structurally sound, and able to withstand the environmental element.

c. Steel

Steel is used for heavy and light structural framing as well as a wide range of building products such as windows, doors and fastenings. As a structural material, steel combines high strength with stiffness and elasticity. Steel may be heat created or altered with adhesive on its manufacture to develop special properties of strength, hardness or ductility, expansion, resistance workability.

Normally ordinary steel (hard yield or soft yield) is subject to corrosion and should be treated (painted, galvanized or chemically treated) for protection against corrosion. The treatments are of different types, which includes, stainless steel, nickel steel, chromium steel and copper bearing steel.

d. Aluminium

Natural light in colour, aluminium may be dyed into a number of warm and bright colours during anodising process. It is often used as secondary building material such as windows, doors, roofing, flashing, reflective insulation, trim and hard ware. Care is usually taken to insulate aluminium from contact with other metals to prevent galvanic action. It is also protected from alkaline material such as hot concrete, mortar or plaster.

e. Copper

It is used in construction where corrosion resistance, ductility or high electrical and thermal conductivity is required, often in sheet form for roofing and flashing.

f. Lead

It is soft malleable plastic, corrosion resistant, used for fastening and piping.

g. Glass

Glass is a chemically inert, transparent, hard and brittle material. It is used in various forms of building construction. Glass is used commonly to glaze building windows and slight openings. There are three basic types of glass; sheet glass, plate glass and float glass. The variations between these three types are many and they include; heat absorbing glass, temperate glass, safety/laminated glass, wired glass, insulating glass, and rein glass.

h. Wood

Wood, in addition to its strength offers durability, lightweight, easy workability, material beauty and warmth to sight and touch. There are two major classes of woods, softwoods and hard woods. They are indicative of their relative hardness, softness or strength. Timber is used mostly for construction as propping materials, doors and window frames, roofing member, partitions, etc.

i. Paint Finishes

The purposes of paint finish are to protect, preserve or visually enhance the appearance of the surface to which it is applied. Paints generally refer to an opaque or clear film – forming material that acts as a shield or barrier between the building materials and those elements or conditions that may adversely affect or deteriorate it. It can enhance the environment, engendering a cheerful receptive mood.

j. Finishes

Finishes are used to ensure that the appearance of the finished work is not only of aesthetic appeal but also enhancing durability and resistance to wearing. Some of the finishes used are briefly highlighted below,

Ceramic floor tiles are used for floor finishes in the offices and the rooms while polished terrazzo granite are used for entrance and areas of hard ware.

Apart from paint finishes on the internal walls and some areas of the external walls, texcote wall finishes are used for quality, durability, and aesthetics and to prevent people from leaning on the wall.

4.4.2 CONSTRUCTION

a. Roof

The roofing system used for most part of this design is treated wood trusses as the design is majorly a short span building and treated timber which also has the ability to withstand fire for two hours (Canadian wood council, 2007). Lattice steel truss, an example of a large span roofing system was used for the halls because the hall is about 20m in width which fits into the category of a medium span area. Roofing system can be categorized into short span, which is up to 7.5m, medium span which is between 7.5m to 25m and large span is that above 25m (Barry, 1972). In the lecture hall area, the metal sections are supported by reinforced concrete columns at intervals specified by the engineer. The triangular lattice frames of light angle steel sections are welded together to support the light section steel angle purlins which also supports the roof and the roof covering. The roof covering to be used is long span aluminum roofing sheet which is light weight and will not affect the strength and rigidity of the structure As the roofing system of the propose design has already been discussed, the other structural components shall be classified into the following headings: -

b. Foundation

c. Floor

d. Wall

e. Columns and beams

b. Foundation

The most critical factor in determining the foundation system of a building is the type and capacity of the soil to which the building loads will be distributed. It is an essential part of the building that transmits the loads (dead, live and imposed load) of the building to the bearing level in the ground. In selecting the foundation of the building, the geology of the soil and the intended load of the building were considered. The strip foundation system will be used for the walls while the pad foundation system will be used for the column points since it is a storey building. This will be designed according to the engineer's specification.

c. WALL

The wall is the vertical element of a building structure which is used to enclose and protect the interior against prevailing weather conditions. It is also used to divide the interior spaces into rooms. The walls will be constructed of 230mm bricks while the internal partitioning of the building be partition with 230mm sandcrete walls of 3.0m height. Plastering will be applied on the internal walls with two coats of paint.

d. Floor

Floor is the horizontal plane in a building which support loads (live and dead loads). Floors transmit loads laterally to the beams, columns and then transmit it all through to the foundation. The floor slab for this design proposal is 150mm thick cast-in-situ reinforced concrete slab to be constructed of concrete laid on 300mm consolidated hardcore. The floor finish for the studios, lecture halls, board room, laboratories, and the library is terrazzo. The floor finish for the offices and other room functions is 300 by 300mm ceramic tiles and that of the toilet areas, is 150 by 150mm.

e. Structural System

The structural system that will be employed in this design proposal is basically the beam and column system. They are the main structural components of the building. It involves the construction of reinforced concrete frame. The structural load of the building will be carried by the beam through the column down to the foundation.

4.5 LANDSCAPE MATERIAL AND EXTERNAL WORKS

Materials used for the soft and hard landscape include the following; trees flowers and grasses are used for soft landscape and built structures, concrete kerbs, walk way, slabs and stones are used for hard landscape.

Plants that grow well in savannah region were selected for the landscape, they include: -

Royal palms: They are basically used for aesthetics and to create link between the built environment and the natural surroundings.

Umbrella trees: Planted to provide shades and to reduce direct radiation from the sun. Mango, guava and orange trees are planted to create a feel of natural environment.

The materials used for hard landscaping are mentioned below:

Concrete walkways: Concrete walkways and terraces are used to create functional circulation and reduce slippery effects on the walkways.

Concrete seats: These are within the site to provide a feel of the natural environment

Kerbs: These are used to protect the edge of grasses from spreading into the walkways, control surface water drainage from the road, prevent erosion, and discourage the encroachment of vehicle on the walkways.

4.6 BUILDING SERVICES

Services are essential components of a building for effective and efficient functioning. It is therefore necessary to accommodate them to facilitate harmony to the functions. These are mechanical electrical and, acoustic services.

4.6.1 Electrical and Lighting

Electrical power is at factor in the smooth running of the faculty, as the workability of any electrical or electronic appliances depends solely on the electrical power supply, which is a determining factor for operational efficiency.

The major supply of electricity is from the Power Holding Company of Nigeria (PHCN) although there is a standby generator provided to further enhance constant power supply. The electrification is not going to be a problem because electric power lines are already on the site hence power will be tapped from it.

The distributions will be all done using conduit system in order to conceal any exposed wires to minimize the occurrence of the fire out-break. Light fixtures and wall switches are the most visible parts of an electrical system and they will be located for convenience, easy access and in co-ordination with visible surface patterns.

The meter, service switches, switch boards, panel boards and branch circuits will be properly installed and separate wiring circuits will be used for sound and signal equipment, alarm system, telephones, television, cable system, lighting system etc. to meet the standard codes of safety, durability and reliability.

Details such as lighting power, telephone, ceiling fans, security lights, fire alarm, etc would be done according with standard practice by the electrical Engineers.

4.6.2 Mechanical (Heating, Cooling And Ventilation)

To sustain comfort within the enclosure in any built environment, the building must have control over the elements. The environmental factors that can be controlled by mechanical means include the temperature of the surrounding air, the mean radiant temperature, dust and odour. Proper planning of the building location and orientation, spacing between buildings, choice of building materials and construction assembly, will reduce the cost of energy consumption in the faculty.

Air conditioning unit will be installed in offices, computer room, studios and some other places necessary while ceiling fans will be provided for in other enclosures. The provision of courtyards will aid ventilation and lighting

4.6.3 Plumbing and Sanitary System

In a building, plumbing work has to do with circulation and storage of water, collection and disposal of used water. For adequate comfort, water supply has to be in the right quantity and at the proper flow rate, pressure and temperature. The water pipes should be of adequate sizes and should be rust and corrosion resistant.

The sanitary drainage system depends on gravitational force of flow and will require large pipes and adequate installation space. All these will be properly put into consideration, and the layout of the sanitary drainage system will be straightforward and direct with properly sloped runs and angular connections.

Plumbing forms an important embodiment of the system within the functional organization of a designated architectural structure. It is required for areas of water need and disposal such as toilets.

4.6.4 Refuse Disposal

On planning the site, roads are properly linked and planned to make refuse disposal easy and convenient on the site. There will be an incinerator in the site to take care of disposed refuse.

4.6.5 Acoustics

Acoustics can be defined as the science of sound, including its origin, transmission, and control of its effects. Sound travels in a wave – like manner and requires a medium to travel. The acoustic design of spaces involves the reinforcement of desired sound and the control of undesirable sound (noise). The acoustics of a space depends on shape, form, volume and the nature of its surfaces.

The acoustic problem in the lecture hall is treated with a suspended ceiling with perforation to absorb/dampen the noise or reduce re-vibration echo. Other areas such as administrative units and conference hall are all treated with same panels on ceiling to avoid noise re-vibration. The use of noised absorbent panels is adopted for the corridors while synthetic carpeting is employed for the floors to reduce feet dragging induced noise. Large spaces are effectively curtained to avoid echo and other acoustic problems.

The external noise is controlled by good site planning, zoning, and by buffering all accesses roads to screen the traffic noise. Hence noise absorption is ensured tree butters are planted and acoustic materials used to achieve this.

4.6.6 Fire Safety

Fire is a destructive element to a building when it is out of control within or outside of a building. It should be of great concern to any designer on how fire should be checked not to get out of control and in case it does how it should be detected and brought under control. Fire safety codes and conducts are to be fully adhered to in order to prevent the occurrence of fire incidence in the faculty building.

Fires in building are nearly always due to human errors or negligence. The principal objectives of fire precaution are simply to safeguard life and property. And this can be achieved by:

i. Reducing fire incidences.

ii. Use of fire resistance materials

iii. Controlling fire propagation and spread

iv. Providing adequate means of escape to occupants of buildings.

Appropriate design specifications and choice of materials amongst others carries out the architectural role in the prevention, detection and combustion of fire. For the purpose of this design, concrete slabs, steel roofs and glass curtain walling serve as fire inhibitors. Also circulation space is provided to aid mass movement should fire break out. High fire resistance materials are employed in area that naked flames and highly combustible materials are used. Roof clearances in all fire prone areas are, taken care of to prevent or fore stall fire reach.

However, fire dictators are provided in the design. These are smoke detectors, fire alarm and portable fire extinguishers are located at strategic points and right level to be used to combat fire outbreak. While special water storage tank, and wet hose are provided for storage of water too.

4.6.7 Security

Security in any building cannot be compromised most especially in a learning environment with students of different background. There are security bits in and around the faculty to control the students. Communication facilities would be provided for, to monitor and co-ordinate activities within the faculty.

4.6.8 Maintenance

The building is designed in a way so that daily and periodic maintenance can be possible. The building shell, floor and exterior envelop and vertical transportation is of concrete block of lifespan of 65 years, reinforced concrete of lifespan 100 years are used for the columns and slabs. The building services are in such a way that periodic check is easy. Walls are finished with texcote paints to keep the colour of the building for some time. The toilets walls finished with tiles for easy cleaning. Maintenance stacks are provided in the interior of the buildings for keeping daily cleaning equipments.

4.6.9 Aesthetics

Architecture is all about functionality and aesthetics. However, at first glance to a building the first things that draw ones interest are the aesthetic of the building. Buildings that are very pleasing to the eyes give a great sense of value to the activities going on within the building and the occupants a feeling of satisfaction and greatness.

Care has been taken to achieve a delicate balance of form and values. Architectural composition has come to play a progressive role in this regard. The elevations are very expressive of solid – state beauty and form. The floor systems are treated with decorative finishes, marble, terrazzo and tiles. Areas where such materials are employed depend on the general traffic flow pattern and the nature of use. The roof systems of some of the buildings are parapet to give the building character of a reliable set – up in organization.

The landscape is treated using the basic landscaping elements of soft and hard landscape features. Neatly grown carpet grass, bush blossoming, flowers of different varieties are to be planted while shrubs and trees of aesthetic qualities like the umbrella stress, flame of the forest, the royal palm, and others are used to adorn the road network by the sides within the faculty.

4.6.10 Solar Control

i) Solar Control In Walls

This varies with the absorptively (colour) the external wall give. While washed surfaces absorb only 15% of the incident radiation. Standard light colours such as cream, light green absorb 40% medium dark shades (dark grey green and red) 60 – 70% and black surface 80 – 90%. Light colour is used for exterior walls in this design.

ii) Solar Control through Windows

This depends on shading devise used; in this design the glazing is of glass with wire mesh composition with dark external shading as little as 10%. The fins act as shading devices for the glazing.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

ICT permeates the business environment, it underpins the success of modern corporations, and it provides governments with an efficient infrastructure. At the same time, ICT adds value to the processes of learning, and in the organization and management of learning institutions. The Internet is a driving force for much development and innovation in both developed and developing countries. Countries must be able to benefit from technological developments.

To be able to do so, a cadre of professionals has to be educated with sound ICT background, independent of specific computer platforms or software environments. Technological developments lead to changes in work and changes in the organization of work, and required competencies are therefore changing.

Architects and designers should look for opportunities to capture, re-use and recycle the energy, water, materials and waste resources available to minimise energy consumption and resources. The integration of buildings with their natural environment and the use of local bio-climate for environmental benefits is fundamental to the design.

As we have seen, there are several design strategies that can be used to encourage the passive cooling of buildings in this climatic conditions. Whilst the reconciliation of increased levels of porosity and degrees of privacy required between faculty offices may be a critical design consideration, there are several strategies that can be employed to optimise wind-flow and encourage the more passive means of cooling the internal spaces.

One of the main problems that passive cooling systems usually present is due to fluctuations in the incidence of casual heat gains within the internal spaces. In a school environment, the likely causes of such gains are the variations in the levels of occupancy, lighting and equipment. Therefore, a careful consideration of other influential aspects, such as the shape and massing of the building, the planning of large public spaces, the properties of the external envelope, etc; is also required.

What this research shows, is that there are several options available to the architect towards a more efficient design in this climatic conditions. Simple strategies that can assist in the modification of the internal conditions include the shaping of the roofs, adaptation of new openings and thin open-plans for the maximisation of cross- ventilation. Large spaces such as lobbies and lecture theatres should be shaded.

The external materials in the roofs and walls are light-weight, insulated, reflective and of quick-response for cooling at night. The roofs are ventilated and double roofed. Projecting over-hangs or louvres are used to shade the surrounding external walls, and veranda spaces. The floors are raised from the ground to encourage airflow under the building. High ceilings and large openings are used for ventilation. Circulation spaces are provided in the form of sheltered breezeways to encourage airflow.

Lastly but most importantly, as we have seen through the precedents, the landscape plays a crucial role in these types of schemes. The vegetation are seen as an integral part of the project, leaves and greenery as low emissivity materials that reflect solar radiation and soften the impact on the landscape.

5.2 CONCLUSION

The passive cooling of a building is based on the cooling power of the outside air to decrease the indoor temperature of the building. Improvement of the thermal comfort can be reached through the decrease of the indoor temperature during occupation hours and the reduction of discomfort periods during the hottest periods of the year.

Different types of passive cooling strategies have been defined and evaluated.

The designs has provided inspirational learning environments shaped around people, and shall deliver improved environmental performance in the present; the building has the ability to incorporate further renewable energy in the future, as the economic and environmental contexts change. Sustainability is a visible part of the educational environment. This has been achieved through the integration of living roofs, planting within the building, low-embodied energy and sustainable brick construction, and the use of renewable energy technologies.

Planning for the integration of the ideas outlined in this project will make it possible to reduce dependency on finite energy sources. New technologies, materials, and access laws can help create a built environment that will make a sustainable lifestyle possible.

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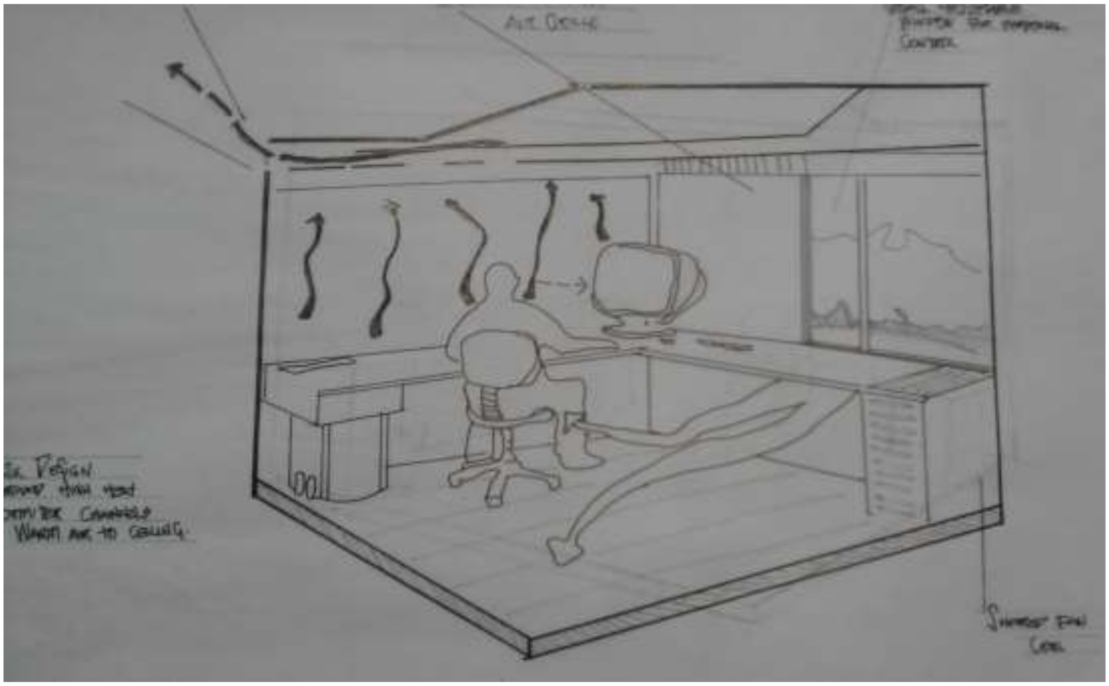
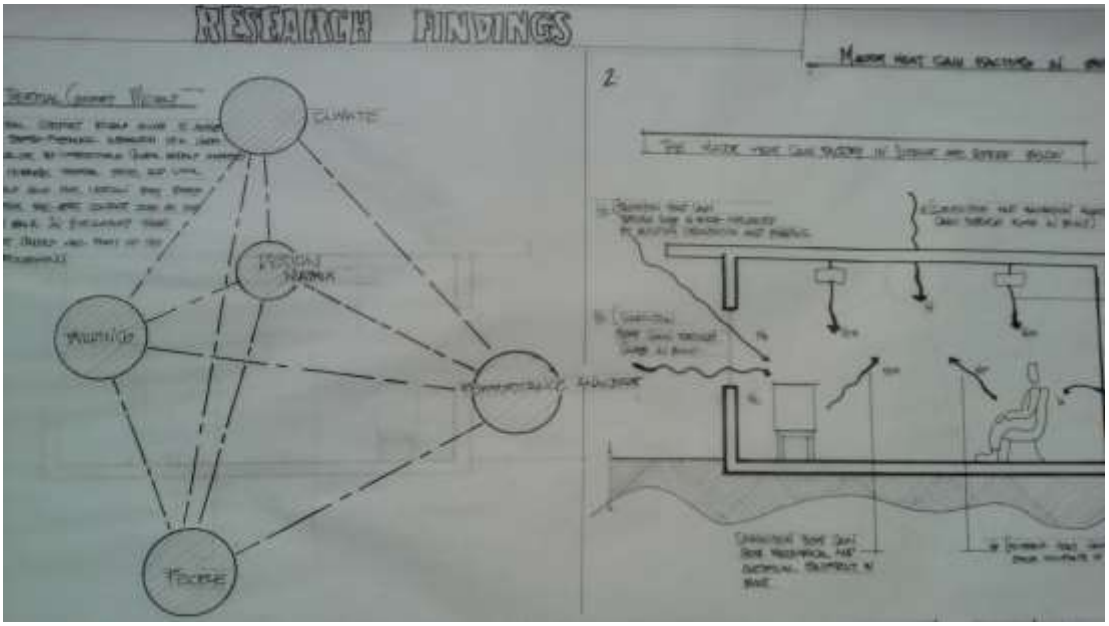
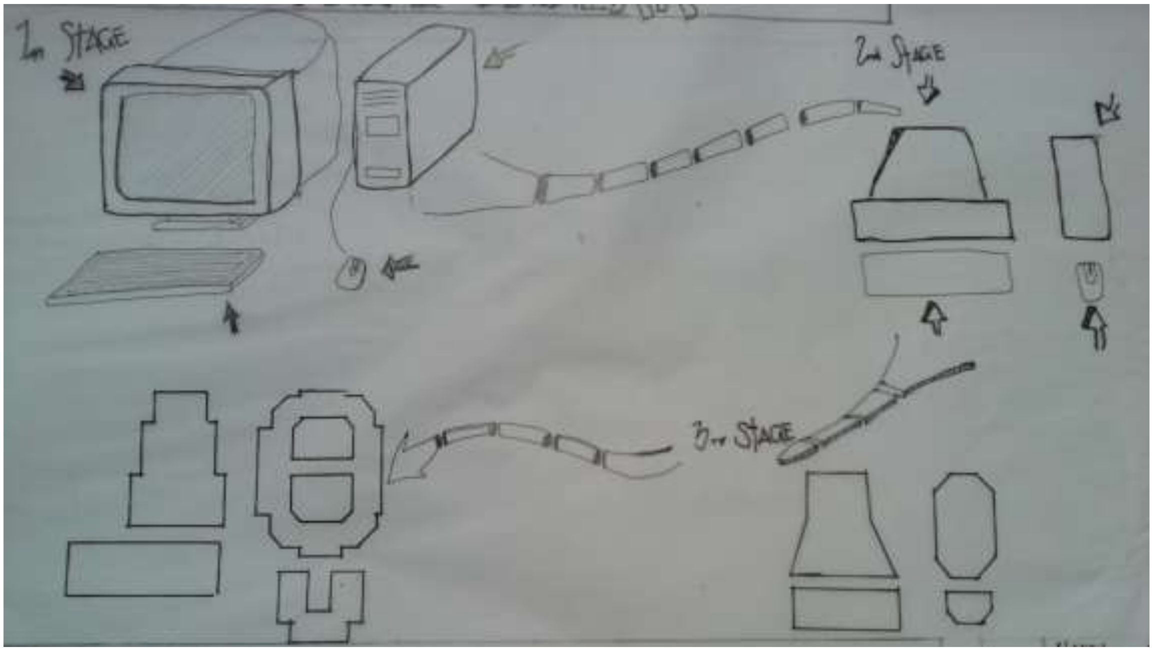
APPENDICES



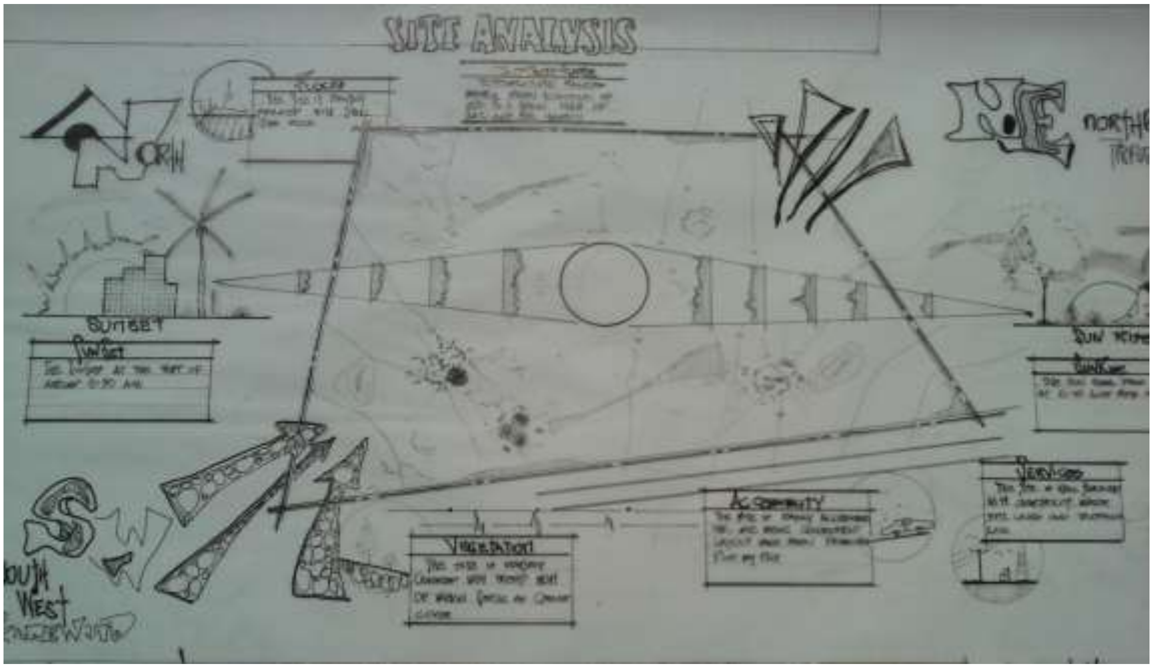
Appendix A: Heat Control In Building.



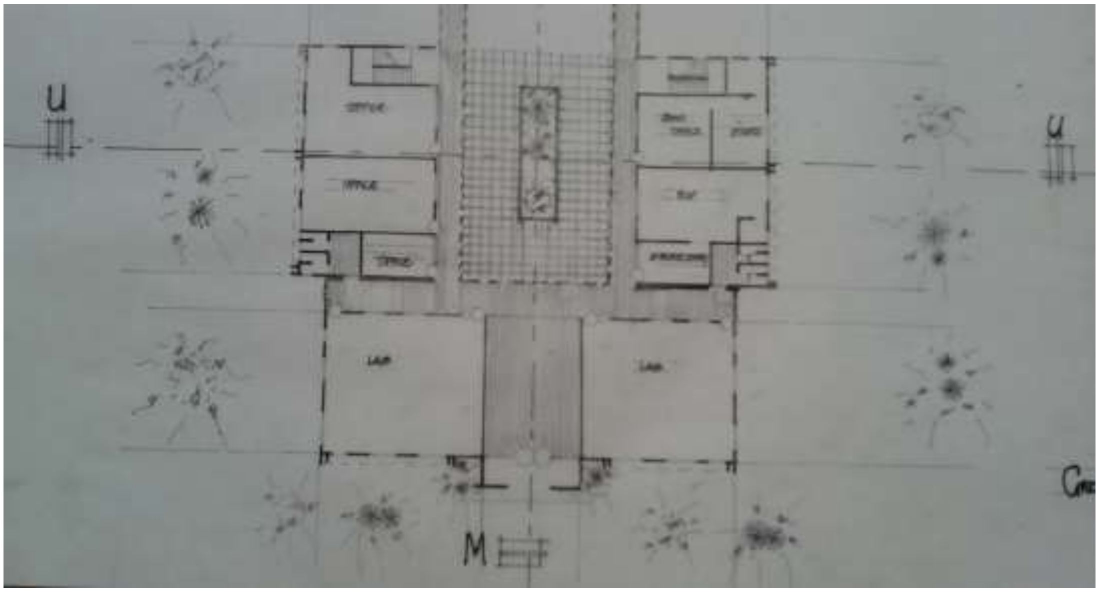
Appendix B: Major Heat Gain In Building



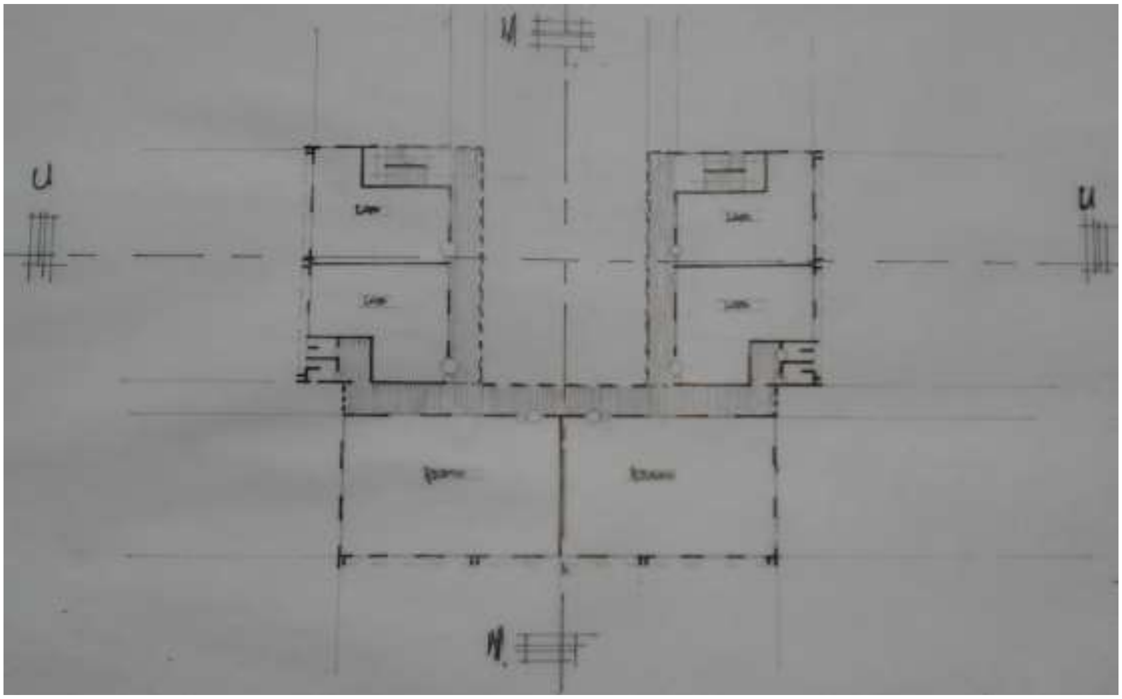
Appendix C: Conceptual Analysis



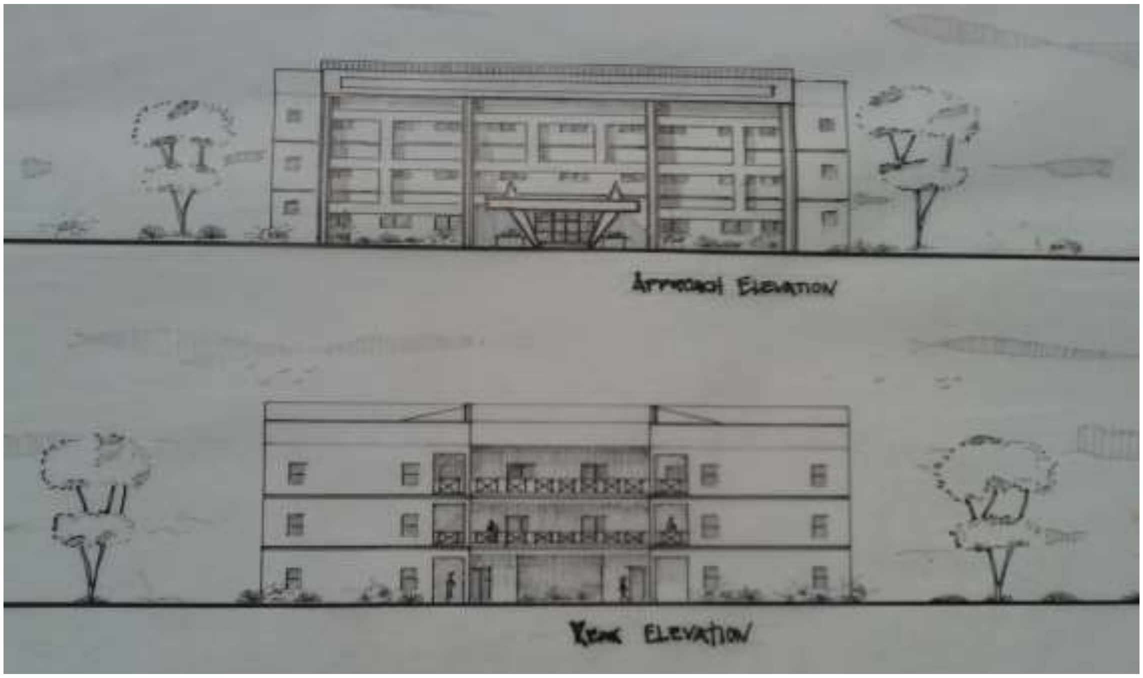
Appendix D: Site Analysis



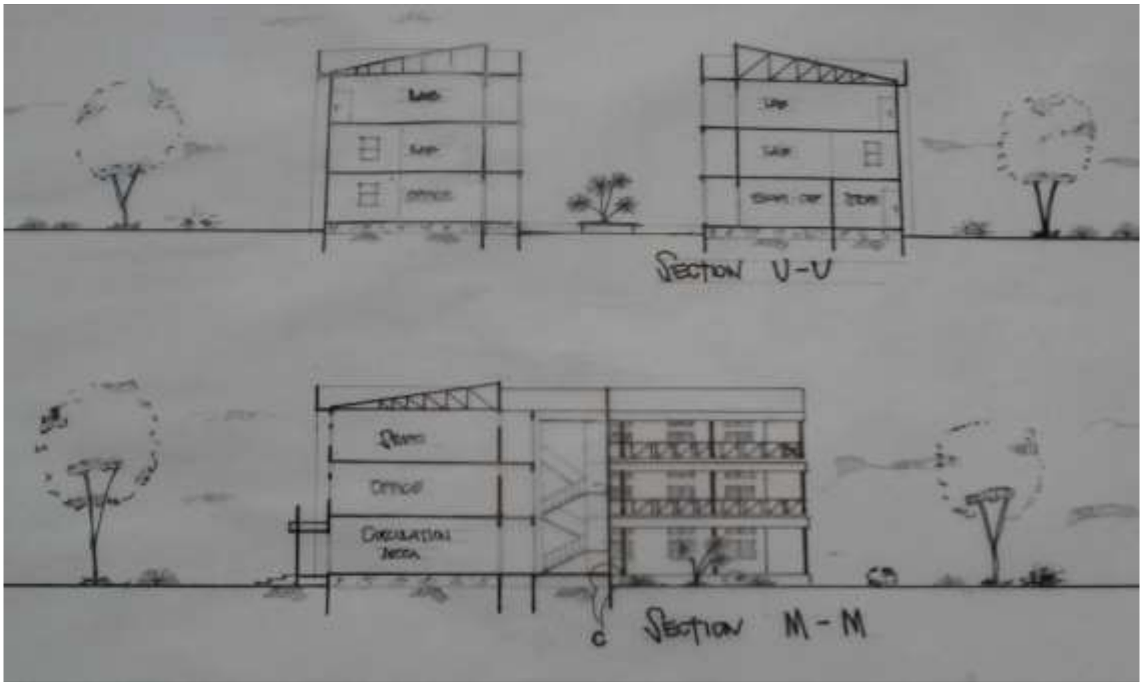
Appendix E: Dean's building Ground Floor Plan.



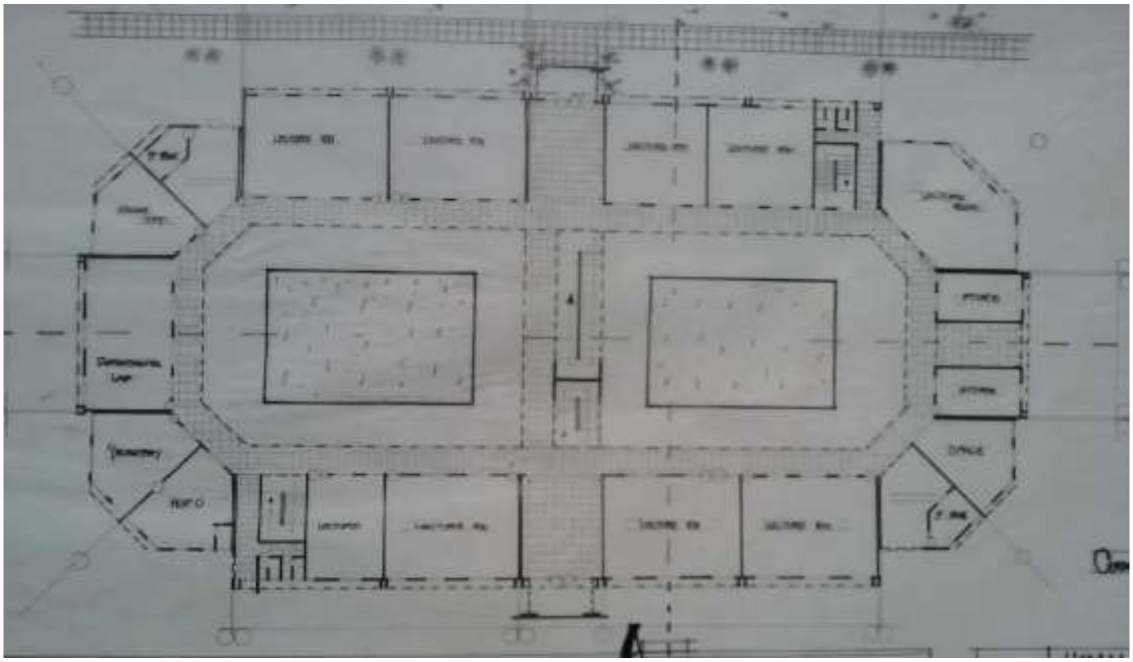
Appendix F: Dean’s building First Floor Plan.



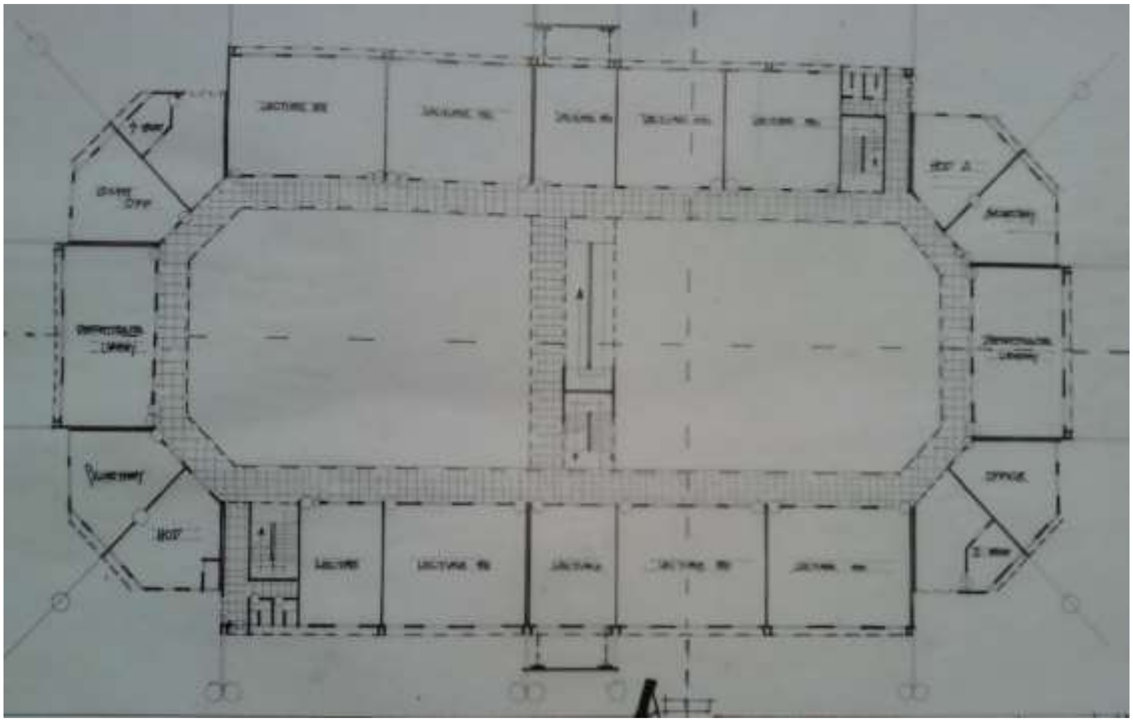
Appendix G: Dean’s Building Elevations



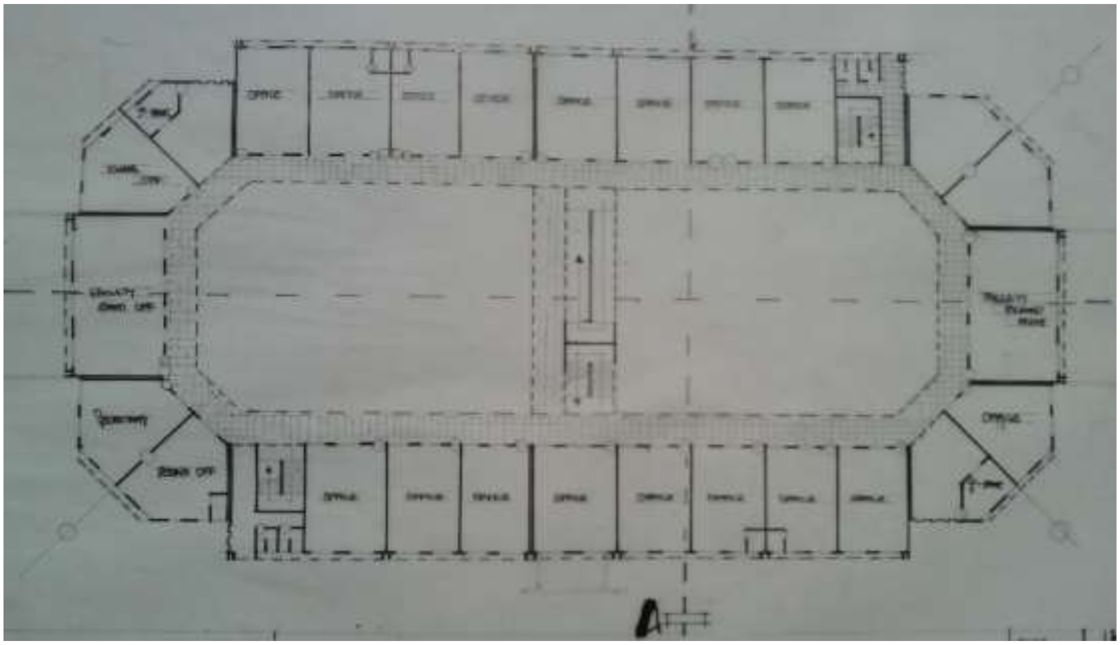
Appendix H: Section M - M



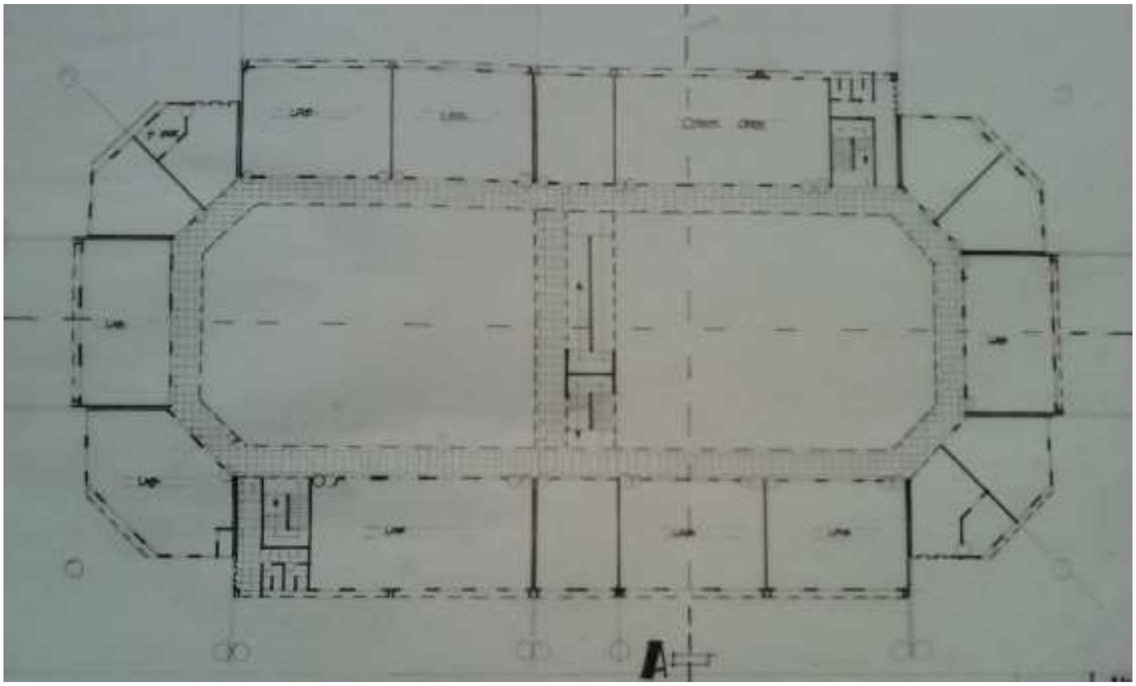
Appendix I: Faculty Ground Floor Plan.



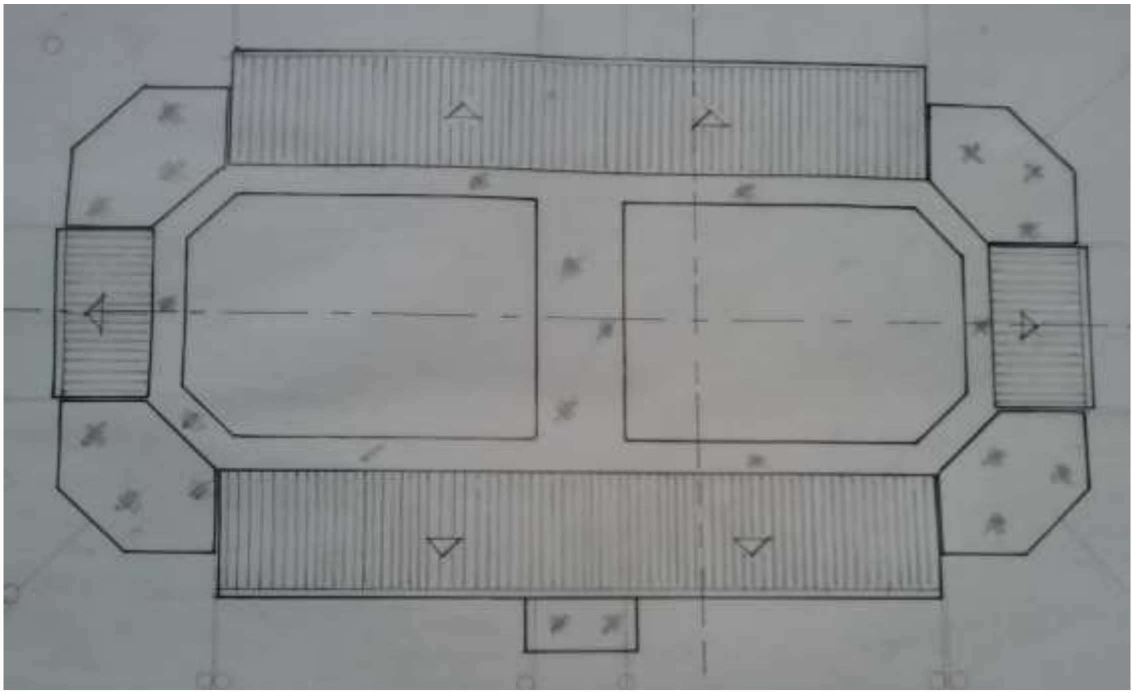
Appendix J: Faculty First Floor Plan.

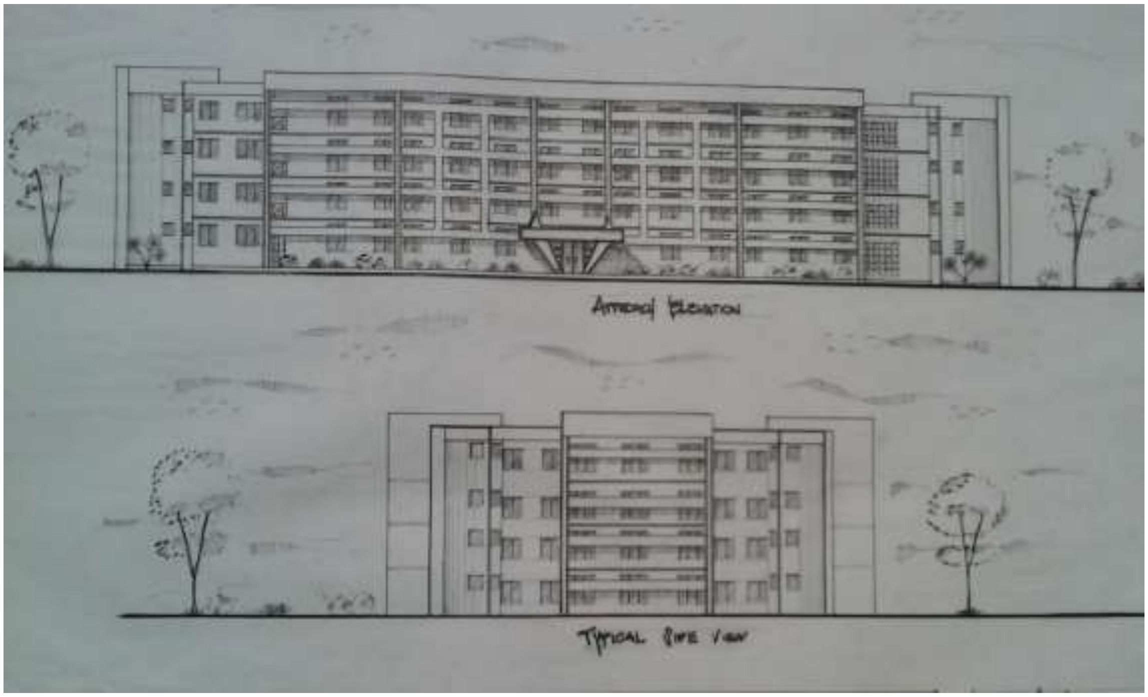


Appendix K: Faculty Second Floor Plan.

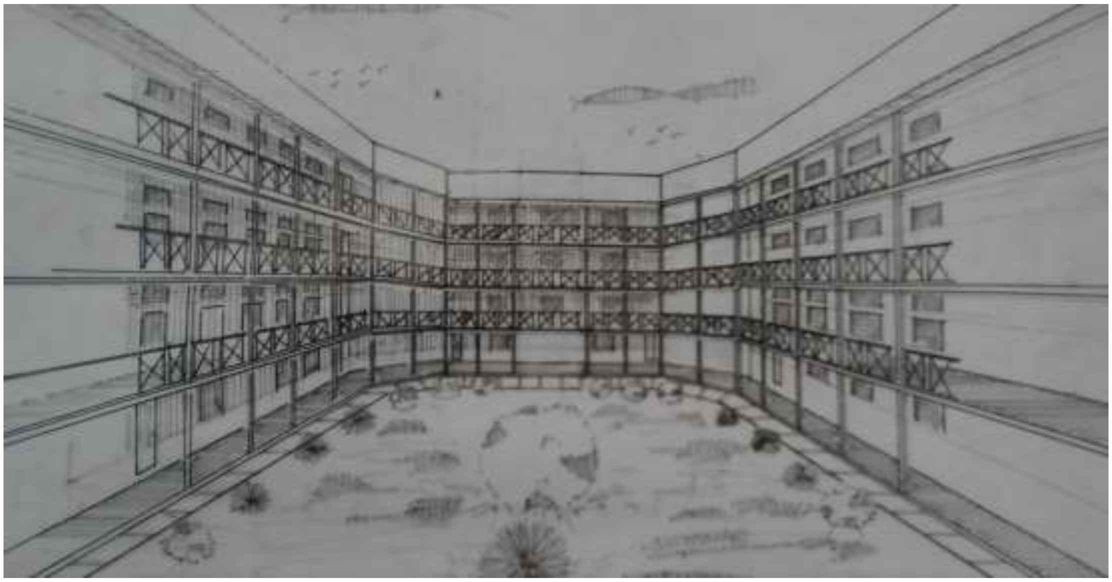


Appendix L: Faculty Third Floor Plan


Appendix M : Roof Plan.



Appendix N: Faculty Elevations.


Appendix O : Interior Perspective.

Appendix P : Exterior Perspective.