DESIGN PROPOOSAL FOR ABUJA ARTS THEATRE WITH EMPHASIS ON THE USE OF GLASS AS A BUILDING MATERIAL

BY

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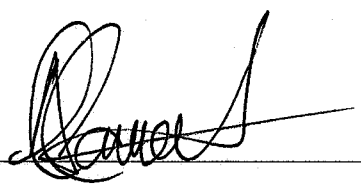
DECLARATION

I, Lawal Amina. O (Miss) of the postgraduate school, department of architecture, school of environmental technology, of the Federal university of technology Minna, hereby declare that the research project entitled '**ABUJA ARTS THEATRE WITH EMPHASIS ON THE USE OF GLASS AS A BUILDING MATERIAL**' is a product of my research work under the supervision of Arc A. Anunobi, my supervisor. All information utilized and their sources have been duly acknowledged by the way of reference.



LAWAL AMINA. O. (MTECH/1047/2003/2004)

CERTIFICATION

This is to certify that this research project entitled **'ABUJA ARTS THEATRE WITH EMPHASIS ON THE USE OF GLASS AS A BUILDING MATERIAL'** is an original work undertaken by Lawal Amina. O. (Miss) (MTECH/SET/1047/2003/2004) under the supervision of Arc A.Anunobi, and has been prepared in accordance with the regulations governing the preparation of the award of Masters of technology degree in the department of architecture, Federal University of Technology Minna. The project has been read and approved by:

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DEDICATION

You can have more than one brother, sister, uncle, aunt, cousin, niece, nephew, or relation, but you can never have more than one set of parents. This research project is dedicated to my dear parents, Amb and Mrs. S. A Lawal, who believe that the greatest gift a child can receive is a sound education.

And in loving memory of Azeez Lawal, my big brother who was hardly around but was always there.

ACKNOWLEDGEMENT

I would first and foremost like to thank God almighty who in my weakness gave me strength and grace to do all things and continues to shower me with blessings. I wish to acknowledge with great appreciation, the assistance of the persons who where of great help and aided me in one way or the other in making my project a reality.

Firstly, I am indebted to Arc A.Anunobi. (my supervisor) for his special assistance, I will always remain indebted to my honourable lecturers for taking time to bestow knowledge upon me. This project would not be complete without expressing my sincere gratitude to my boss Arc Tunde Oyekola. Thank you for always keeping an open door for me. Most importantly, I wish to express my deepest thanks to the members of my family: My most beloved parents, Amb and Mrs. S.A Lawal to my sisters (the chic clique) and brothers, and Mrs Lawal Jnr wishing them all the best in their daily endeavours in life. A special love goes to my dear friends who I am indebted to, and lastly but not the least my dearest Snookles thanks for always being there.

ABSTRACT

Within the last century, new building materials have emerged, and old ones have been improved upon. Glass falls into the latter category. Glass was discovered in 3500 B.C. and has undergone so much change since then.Traditionally glass has been used for its clarity and rigidity which prevents wind, cold and dust to get inside a building but allows light to penetrate into internal spaces as well as to give a clear view of external space. With time the desire to satisfy modern needs caused the development of glass into a tough industrial product with many additional characteristics and possibilities. The demand for ever higher quality, an ever greater variety of products and the desire for ever more unique and complicated pieces that will impress, also drives the developments in the industry. Glass was used mainly as doors and windows, but now it can be used as structural elements of a building.

A theatre is a building, room, or other setting where plays, theatrical or other dramatic presentations are performed and viewed. Presently, Abuja does not have a theatre, and this proposal aims to satisfy the needs of the residents in terms of a suitable venue for showcasing and viewing performing arts.

In the future, the use of glass as a predominant building material is surely to increase for both the exterior and interior of buildings. Techniques and aesthetics which are ever more important are ever easier to achieve with new technology in glass production.

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CHAPTER 1 – INTRODUCTION

1.1 INTRODUCTION

The Federal Government decree number 6 of February 1979 established Abuja the Federal Capital Territory (FCT) as the new capital of Nigeria. Since then, ministries, parastatals, and the private sector have been relocating from Lagos, the previous capital of Nigeria. Within the past five years the influx of people into the FCT has been astounding. The accommodation provided by the federal government can barely contain the population. As the population grew social amenities like hotels, clubs, shopping centres, resorts and so on were provided. This took care of the active social needs of the population, but the passive social needs have not yet been adequately met. Even though all forms of government amenities relocated from Lagos, The National Theatre did not. This led to the almost non existent showcasing of dramas, concerts, plays and movies because of the lack of a venue suitable to house the population of Abuja. Presently, hotel conference rooms, and the auditoriums in the women's centre and the Nigerian Universities Commission are being used. The Nigerian Universities Commission auditorium can only be used weekdays, during working hours, and the use of the auditorium in the women's centre is more flexible, but lacks appropriate facilities. The lack of a suitable venue has resulted in a decline of the growth and spread of performing arts, and the high cost of tickets whenever an event is showcased. Sometimes, shows are presented two or more times during a day to accommodate the audience, and still the venues are crowded.
In the past, when glass was mentioned in buildings, it was assumed that the glass was used for the doors and windows. But in recent times, glass can be used for any element of a building not compromising the strength and stability of the building. Due to its brittle nature, it is usually assumed that it is unsuitable for rooms where acoustic control is needed because it would reflect the sounds, But this research shows otherwise.

1.2 AIM OF STUDY

Considering the problems faced by the residents of the FCT in terms of a suitable venue to watch performing arts, the aim of this thesis shall be an attempt at providing a conducive venue for interested residents of the FCT to adequately watch and enjoy any form of performing arts at regular intervals. The research also aims at realizing if glass is a suitable

type of building material, the types of glass suitable, and where such glass can be used in a building.

1.3 OBJECTIVES OF STUDY:

The following objectives have been identified in the pursuit of the stated goal. They include:

- Achieving an environment where members of the public could go and view any chosen form of art comfortably.
- Achieving an environment that encourages members of the public involve themselves in activities that would promote the performing arts of Nigeria.
- Creating an avenue for the Nigerian movie and theatrical industry to generate revenue through means other than sales of their productions.
- Creating an avenue for the government to generate revenue through the renting of halls within the theatre premises.

1.4 MOTIVATION

Going to a theatre to watch any form of performing arts should be a form of passive recreation, not an uncomfortable experience. In Abuja, spectators have to reach the proposed venue about an hour or two, just to secure a comfortable seat, even then, the spectator cannot guarantee total comfort due to the likelihood of encroaching squatters, which has led to a decline in the patronage of such events.

1.5 SOURCESOF DATA

In view of the nature of the topic, the data used would be sourced both primarily and secondarily.

The primary source of data would be obtained from interviews, while the secondary source would be obtained from books, magazines, journals and the Internet.

1.6 METHODOLOGY

For this research, the descriptive survey method was used; studies of some existing theatres were carried out, noting the type of facilities in each theatre, the problems being faced (if any), and their merits and demerits. Interviews were also carried out with a few residents of Abuja.

Data retrieved from journals, books, magazines and the Internet would also be given adequate attention.

1.7 SCOPE OF WORK

The thesis shall focus on areas relating to performing arts which would include dramas, concerts, dances, exhibitions, and other such related acts. The theatre would also have lettable halls which could be used for weddings, receptions, and meetings. Shops would also be provided.

1.8 LIMITATIONS

Some of the limitations faced while carrying out the research include:

- Libraries not having up to date publication
- Unwillingness of the relevant authorities to release information in some of the theatres visited.

The above mentioned limitations resulted in most of the data being sourced from the internet.

1.9 IMPORTANCE OF STUDY

In recent times, Nigerian works of art are receiving attention worldwide, especially performing arts. A nation's capital should be the main point where such works of art can be viewed (apart from the origin of the work). The lack of a befitting theatre in Abuja is crippling the growth and spread of such works of art. The existence of a theatre would bridge the growing gap between the lovers of art (especially performed arts) and creators of such forms of art.

CHAPTER 2 – LITERATURE REVIEW (ARTS THEATRES)

2.1. INTRODUCTION

Theatre is essentially the interaction between the actor and the audience. The relationship of actor to audience develops in parallel with the setting that the actor places himself in the technological complexity of that setting.

The term theatrical performance is often applied only to dramatic and musical plays, but it properly includes opera, dance, circus and carnivals, mime, vaudeville, puppet shows, pageants, and other forms—all of which have certain elements in common. They are essentially visual; are experienced directly (although film, videotapes, or recorded sound may be incorporated into a performance); and are governed by sets of rules—such as scripts, scenarios, scores, or choreography—that determine the language and actions of the performers; language, action or atmosphere may be contrived, in order to elicit emotional responses from the audience.

Theatre is an amalgamation of art and architecture; literature, music, and dance; and technology. "The word is from the Greek theatron, "a place of seeing." A theatre usually has a stage area where the performance itself takes place."[1]

Theatre has been used as an extension of religious festivals, as a means for spreading political ideas or propaganda to mass audiences, as entertainment, and as a form of art. "Through much of history, theatre has existed on three levels simultaneously: as loosely organized popular entertainment, as a mainstream public activity, and as an élitist art form."[2] At the level of popular entertainment, it consists of individuals or small groups, usually working outside established theatrical channels, performing anything from circus skills to farcical plays for a mass audience. This form pre-dates the oldest known plays and is exemplified today by commercial television. Theatre as a mainstream public activity is most commonly literary drama performed at public theatres; it is usually commercial or else state-supported for the general public. Greek tragedy, medieval morality plays, and contemporary theatre all fall into this category.

A theatre is a building, room, or other setting where plays or other dramatic presentations are performed. They are structures designed for theatrical performances and their audiences.

2.2 HISTORICAL DEVELOPMENT OF THEATRES

The development of theatres varied in the different regions of the world.

2.2.1 WESTERN THEATRE

Although the origins of Western theatre are unknown, most theories point to a ritual origin in ancient and prehistoric rites and religious practices, because virtually all ritual contains theatrical elements. Different schools of thought attribute origins variously to ancient fertility rites, harvest festivals, shamanism, and similar sources.

The earliest period in Western theatrical history is called Classical, because it encompasses the drama and theatre of the classical civilizations of ancient Greece and Rome.The first evidence of dramatic literature dates from Greece in the 6th century BC. The form of the Greek physical theatre evolved over two centuries; interestingly, the permanent stone theatres that survive today as ruins were not built until the 4th century BC—that is, after the classical period of playwriting. In ancient Greece, in order to see and hear in the open air, the audience was steeply raked for closeness. The Greeks developed the outdoor amphitheatre to have clear acoustics from the stage and circular orchestra area to the large audience, a fine example of which can be seen at Epidaurus. (Figure 2.1).

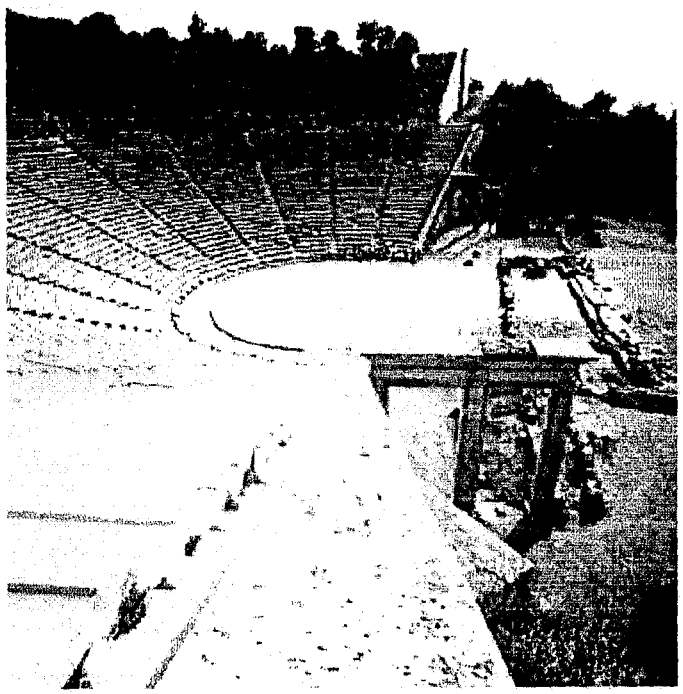

Figure 2.1 – theatre at Epidaurus

Sourced from Encarta encyclopedia premium suite (2004).

"Plays were presented not purely as entertainment, but as an act of worship, which it was the right and duty of every citizen to attend."[3]

The open-air theatres may have consisted of an orchestra—a flat circular area used for choral dances—a raised stage behind it for actors, and a roughly semicircular seating area built into a hillside around the orchestra. These theatres held 15,000 to 20,000 spectators. As the importance of actors grew and that of the chorus diminished, the stage became higher and encroached on the orchestra space. In keeping with its religious function, the theatre was state supported; admission was free or nominal to everyone.

As the Roman Republic began to spread in the 4th century BC, it absorbed Greek territories and, naturally, Greek drama and theatre architecture. Native Roman drama did not develop until the 3rd century BC. The Roman theatre building, as that of Greece, developed after the period of classical writing had ended. In part, this happened because the Romans were afraid to offend one god by building a theatre in honour of another. Roman theatres first appeared in the late Republic. They were semicircular in plan and consisted of a tall stage building (the proscenium) abutting a semicircular space for dancers and chorus (the orchestra) and tiered seating area. Because the chorus had become insignificant, the orchestra was substantially reduced to a small semicircle. The use of the arch permitted the construction of free-standing theatre buildings, as opposed to the Greek use of natural slopes and hillsides to support the seating area. Roman theatres were supported by their own framework of piers and vaults and thus could be constructed in the heart of the city. Amphitheatres (literally, double theatres) were elliptical in plan with a central arena, where gladiatorial and animal combats took place, and a surrounding seating area built on the pattern of Roman theatres.

A good example is the Colosseum (ad 70-80) which held approximately 50,000 spectators, roughly the capacity of today's large sports stadiums. With the fall of the Roman Empire in AD 476, classical theatre came to an end in the West; mainstream theatrical activity did not re-emerge for more than 500 years.

2.2.2. ASIAN THEATRE

Asian theatre developed independently of Western theatre from 2000 BC and grew out of religious ceremonies. The Hindu epic writings, the Mahabharata and Ramayana, formed the basis of theatre in India, Indonesia, and Malaysia, and are still used in wayang kulit

shadow puppets today where the audience gathers around the dalang (puppeteer and narrator) to view the performance from in front or behind the screen.

Chinese theatre evolved over six centuries from open air performances in front of temples to a very high art form in the 19th century, taking place in court theatres or in tea houses with a roofed stage with little scenery, surrounded on three sides by galleried pavilions of audience. The consumption of food and drink by the audience remains very much part of the ritual.

Japanese theatre developed in two forms, the refined no drama and the more popularist kabuki, combining with aspects of Bunraku or puppet theatre. The no stage is wide, having an entrance bridge to one side and an acting pavilion in the centre. The audience sits in front of the stage in a wide auditorium to follow the subtle movements and sounds of the masked characters.

Kabuki theatre developed a raised actors' entrance through the audience—the Hanamichi, a raised platform leading to the central acting pavilion. The audience surrounds the auditorium on three sides in tiered boxes. The stagecraft associated with kabuki performances is complex, requiring a stage revolve and many traps in the stage floor. There are many examples of modern kabuki and no theatres throughout Japan.

In Asia, puppet theatre remains a popular art form, particularly in Indonesia where wayang golek uses large solid puppets on a raised stage to tell traditional tales.

2.2.3 EUROPEAN THEATRE

Theatre in the form of liturgical drama was reborn in Europe in the Roman Catholic Church. As the Church sought to extend its influence, it often adopted pagan and folk festivals, many of which had theatrical elements. By the 10th century the various church services provided possibilities for dramatic presentation; indeed, the Mass itself is not unlike a drama. Certain holidays were celebrated with theatrical activities, such as the procession to the church on Palm Sunday. Over the next 200 years liturgical drama slowly evolved, with various stories from the Bible enacted by the clergy or by

choirboys. At first, church vestments and existing architectural features of the church served as costume and setting, but soon more formal arrangements were devised. As liturgical drama evolved, many thematically related Bible stories were presented sequentially, usually depicting scenes from the creation through the crucifixion. Although the Church encouraged early liturgical drama because of its didactic qualities, entertainment and spectacle became increasingly prevalent, and the Church once again voiced misgivings about drama. Unwilling to relinquish the beneficial effects of theatre, the Church compromised by removing presentation of drama from the church building and relocated them elsewhere. The same physical arrangement was re-created in town-market squares. While the drama retained its religious content and intent, it became increasingly secular in its presentation. By the 14th century the production of plays was associated with the Feast of Corpus Christi. Three major forms of staging were employed. Pageant wagons were most common in England. The former mansion became an elaborate rolling stage, somewhat like a small, modern-day parade float, that would move from place to place in the city. Spectators would assemble at each location; the participants would perform on the wagons and on a platea created on the street or with an adjoining platform. A variant of this method was used in Spain. In France, simultaneous staging was employed—several mansions would be erected side by side on a long, raised platform stage in front of an assembled audience. Finally, again in England, plays were sometimes staged "in the round"—in a circular area with mansions spaced about the circumference and the audience sitting or standing among the mansions. In the 18th century, it became more elaborate. The scenery had expanded outside the acting area to provide curtains and horizontal blinds to the audience area of these outdoor theatres. Scenic and architectural practices developed at this time have influenced theatre production to the present day. Architecturally, an attempt was made to recreate the Roman stage. "The early Italian theatres, however, were constructed in existing spaces such as palace halls or courtyards that were rectangular in shape. Scenically, the most important development was the discovery of perspective technique; painting on a flat surface to create the illusion of depth or space" [4]. This permitted the construction of stage scenery that created the illusion of a real place. It was not until the 17th century that permanent theatres were built. By the end of the 18th century theatres grew larger. Fly towers were built above the stage so the clothes could be flown out of sight by means of

hemp lines and pulleys, and it was now possible to raise and lower the front curtain. This led to allowances being made above the stage while designing theatres.

European theatre during the 19th century developed the concept of a multitiered audience around a central volume containing the majority of the audience, facing the stage. This form was also adopted for many Opera houses. There was also a single rake, fan-shaped room with no people on the sides, the whole audience facing into the stage separated by the deep orchestra pit and technical zone intended to create a suspension of reality by sound and light.

The early to mid-20th century theatres evolved with structural technology to have longer cantilevered balconies and longer rows of seats in an attempt to democratize the layout and provide equal views to the audience. However as audience capacities increased and regulations for safety and comfort developed, this aim became harder to achieve without distancing the whole audience from the stage.

In the latter half of the 20th century, the building of theatres has become an international and multidisciplinary activity. The role of the Theatre Consultant has developed to ensure that the theatrical elements of the building are intact and that the intensity and energy of a performance is communicated to ever increasingly sized audiences. Small flexible theatres became popular in the 1980s to house drama, concerts, operetta, and promenade performances.

As productions tour throughout the world, so theatres are receiving a greater variety of performances in one space and adjustments can be made to suit dance, drama or music. When the adjustments to the theatres are made physically, acoustically, and visually to change the location of the audience to the proscenium, thrust, or arena stages, and the acoustics from music to speech, a multi-purpose space is created.

The current international flavour of performances with their cross fertilization of staging ideas between Eastern and Western theatre, the blending of artforms, and use of multimedia for scenery techniques, herald an exciting era in theatre production which will lead to future evolution of the architecture surrounding the performance.

2.2.4. AFRICAN THEATRE

Contemporary African theatre ranges from sacred or ritual performances to dramatized storytelling, literary drama, or modern fusions of scripted theatre with traditional performance techniques.

African plays were produced in indigenous and European languages from the 1880s onward. Western missionaries sought to instill Christian values through biblical dramas and pageants. The period of colonial domination in Africa was consolidated at the Conference of Berlin in 1884-1885, when the European powers mapped out the division of Africa. The colonization led to the suppression and outlawing of many indigenous art forms and belief systems such as drumming and dancing, resulting in Africans adapting European dramatic forms instead of their own satirical or political purposes.

The period after World War II led to the struggle for and achievement of independence in many African countries. The new nation states were often established along colonial boundaries and power was handed over to a bourgeois class who had been educated in Europe. "The epoch-making era of nationalism produced a number of African playwrights who merged African theatrical traditions with European forms. "[5]

The new regimes soon inspired playwrights to use theatre for political opposition. During the 1970s a number of military and discriminatory regimes held power, In opposition to these regimes, playwrights turned to radical and propagandist forms of theatre. Simultaneously there was a reaction against bourgeois literary drama; theatre companies increasingly sought to speak to the urban and rural poor and to include them in their activities by moving out of national theatre buildings and into the local areas. Architecturally, the development of theatre in Africa was similar to that of our colonial masters.

2.3 CLASSIFICATIONS OF THEATRES

The presentation of drama varies from one generation to the other and across cultures, but most can be categorized roughly as either presentational or representational. Most African, Oriental, pre-Renaissance Western, and 20th-century avant-garde theatre is presentational. The stylized approach of presentational theatre makes no attempt to hide its theatricality and often emphasizes it. Representational theatre, on the other hand, is illusionistic. Most Western theatre since the Renaissance have been essentially

representational: plays have had plausible plots, characters have seemed true to life, and scenery has tended towards, or been suggestive of, the realistic.
Most performances do not fall neatly into one or the other category but may contain elements of each.

2.4 TYPES OF THEATRES

A) Subsidized Theatre

A subsidized theatre is financially underwritten by a government or by a philanthropic organization. Because of the considerable expense of mounting a theatrical production, the limited audience capacity of most theatres, and, often, the limited appeal of much theatre to the population as a whole, many theatres can only remain financially solvent and mount quality productions with subsidies to supplement box-office income.
Most countries have a designated national theatre company supported by the state.

B) Commercial Theatre

A commercial theatre appeals to a large audience and is produced with the intention of making a profit. The basis of a commercial theatre is entertainment. Social relevance and artistic and literary merit are secondary considerations..

C) Non-Commercial Theatre

Attempts to circumvent the economics peculiar to commercial theatre since the end of the 19th century have resulted in the evolution of non-commercial theatre. Known as art theatre in Europe and America before World War I, and later as experimental theatre, it is often identified today in New York as Off-Broadway and Off-Off-Broadway (the latter being a reaction to the increasing commercialism of the former), in England as fringe theatre, and elsewhere by a host of other names. The various goals of such theatre include presenting more serious, literary, politically active, artistic, and avant-garde drama; experimenting with new forms of production, acting, and design; and giving voice to new playwrights, actors, and directors. Non-commercial theatres try to survive on box-office income and donations, but in recent years it has become increasingly dependent on state and private subsidy. Non-commercial theatres that survive in recent times have almost become as commercial as the theatre they once rebelled against.

D) Community and Academic Theatre

Community theatres are generally non-professional, consisting of members of a community who practice theatre as an avocation. The repertoire of community theatre tends to be commercial fare, although this may vary. Academic theatres, as the name suggests, is produced by educational institutions, most often colleges and universities. "The educational purpose of such theatre results in a repertoire often weighted towards the classical and experimental."[6] Some colleges have technical facilities that surpass those of commercial theatres. Academic theatres are the most active in Nigeria. It is responsible for more theatre than all other Nigerian forms combined.

2.5 THEATRE ORGANIZATION

Theatres may be divided into three parts

a) RECEPTION: this accommodates the entrance, booking hall, foyer, conveniences, and in most Nigerian theatres, exhibition space.

b) AUDITORIUM: this is the space for the audience to sit.

c) STAGE: this part of the theatre houses the stage; main stage, backstage, storage facilities, dressing rooms, costume room, changing rooms, and other rooms concerned with the performances.

2.6 THEATRE SPACE AND STAGE DESIGNS

These schematic diagrams below (figure 2.2) show some of the different forms of stage that have been developed over the years to accommodate different styles of theatre. The proscenium theatre, or picture-frame stage, *top left,* is the most common version of an end stage: a wall frames most of the acting space and separates it from the auditorium. The theatre-in-the-round, or arena theatre, *bottom left* features an acting area that is surrounded by the audience on all sides. Two variations of an open stage are pictured on the right. An open stage, also known as a thrust stage, has seats arranged around a platform that extends into the audience.

Throughout history, however, most theatres have employed one of three types of stage: end, thrust, and arena. An end stage is a raised platform facing the assembled audience. Frequently, it is placed at one end of a rectangular space. The simplest version of the end

stage is the booth or trestle stage, a raised stage with a curtained backdrop and perhaps an awning. This was the stage of the Greek and Roman mimes, the mountebanks and wandering entertainers of the middle Ages, and popular entertainers into the 20th century.

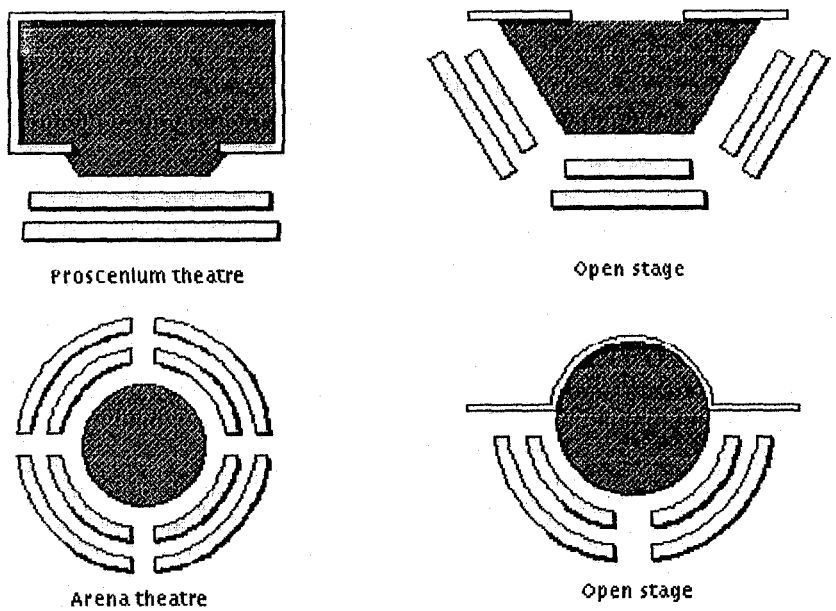

Figure 2.2 various stage designs.

Sourced from Encarta encyclopedia premium suite (2004).

Theatre can also be discussed in terms of the type of space in which it is produced. Stages and auditoriums have had distinctive forms in every era and in different cultures. New theatres today tend to be flexible and eclectic in design, incorporating elements of several styles; they are known as multiple-use or multiple-form theatres.

A) The Proscenium Theatre

Since the Renaissance, Western theatre has been dominated by an end stage variant called the proscenium theatre. The proscenium is the wall separating the stage from the auditorium. The proscenium arch, which may take several shapes, is the opening in that wall through which the audience views the performance. A curtain that either rises or opens to the sides may hang in this space. The proscenium was developed in response to

the desire to mask scenery, hide scene-changing machinery, and create an offstage space for performers' exits and entrances. The result is to enhance illusion by eliminating all that is not part of the scene and to encourage the audience to imagine that what they cannot see is a continuation of what they can see. Because the proscenium is (or appears to be) an architectural barrier, it creates a sense of distance or separation between the stage and the spectators. The proscenium arch also frames the stage and consequently is often called a peep-show or picture-frame stage. It was developed in Italy, in the Renaissance theatre of the 16th century, and may have been partly influenced by the structure of Roman theatres.

B) The Thrust Stage

A thrust stage, sometimes known as three-quarter round, is a platform surrounded on three sides by the audience. This form was used for ancient Greek theatre, Elizabethan theatre, classical Spanish theatre, English Restoration theatre, Japanese and Chinese classical theatre, and much of Western theatre in the 20th century. A thrust may be backed by a wall or be appended to some sort of end stage. The upstage end (back of the stage, farthest from the audience) may have scenery and provision for entrances and exits, but the thrust itself is usually bare except for a few scenic elements and props. Because no barrier exists between performers and spectators, the thrust stage generally creates a sense of greater intimacy, as if the performance were occurring in the midst of the auditorium, while still allowing for illusionistic effects through the use of the upstage end and adjacent offstage space.

C) The Arena Stage

The arena stage, or theatre-in-the-round, is a performing space totally surrounded by the auditorium. This arrangement has been used in the 20th century, but its historical precedents are largely in non-dramatic forms such as the circus, and it has limited popularity. The necessity of providing equal sight lines for all spectators puts special constraints on the type of scenery used and on the movements of the actors, because at any given time part of the audience will inevitably be viewing a performer's back. Illusion is more difficult to sustain in an arena, since in most set-ups, entrances and exits must be made in full view of the audience, eliminating surprise, if nothing else.

Nonetheless, the arena, when properly used, can create a sense of intimacy not often possible with other stage arrangements, and, as noted, it is well suited to many non-dramatic forms. Furthermore, because of the different scenic demands of arena theatre, the large backstage areas associated with prosceniums can be eliminated, thus allowing a more economical use of space.

D) Variant Forms

One variant form of staging is environmental theatre, which has precedents in medieval and folk theatre and has been widely used in 20th-century avant-garde theatre. It eliminates the single or central stage in favour of surrounding the spectators or sharing the space with them. Stage space and spectator space become indistinguishable. Another popular alternative is the free, or flexible, space, sometimes called black-box theatre because of its most common shape and colour. This is an empty space with movable seating units and stage platforms that can be arranged in any configuration for each performance.

E) The Fixed Architectural Stage

Most stages are raw spaces that the designer can mould to create any desired effect or location; in contrast, the architectural stage has permanent features that create a more formal scenic effect. Typically, ramps, stairs, platforms, archways, and pillars are permanently built into the stage space. Variety in individual settings may be achieved by adding scenic elements.

F) Auditoriums

Auditoriums in the 20th century are mostly variants on the fan-shaped auditorium. These auditoriums are shaped like a hand-held fan and are usually raked (inclined upwards from front to back), with staggered seats to provide unobstructed sight lines. Such auditoriums may be designed with balconies, and some theatres, such as opera houses, have boxes—seats in open or partitioned sections along the sidewalls of the auditorium—a carry-over from Baroque theatre architecture.

2.7 ARTS THEATRES IN NIGERIA

Theatre study and practice began at the University of Ibadan as an extra-curricular activity in 1949, with Randall Hogarth as the first producer. He employed the talents of students and teachers in training to elevate the social life on campus. "The gradual evolution of drama from extra mural activity to a teaching subject could be traced to his initial brilliant efforts and impetus." [7]Randall Hogwarth greatly initiated dramatic culture and promoted theatrical awareness. Through Hogwarths' theatre tradition launch, he provided a solid foundation for theatre education and practice in Nigeria on which Geoffrey Axworthy, Wole Soyinka, Yinka Adedeji, Dapo Adelugba, and a host of others built their reputation. In 1995, the university arts theatre was opened. It was a remarkable land mark in theatre education and play production. The educational programmes incepted at the arts theatre in 1963 have matured into full university degree programmes. "Through its wide-ranging art programmes, Ibadan's arts thaetre became in ten years, also a training ground for creative artists, and technicians who led the remarkable development of all the performing arts in the country."[8]

The type of productions that have taken place in the arts theatre since 1955 can be divided into three categories:

- European 1955 – 1958
- Euro – African 1958 – 1974
- African 1974 to date.

2.8 DEFINITION OF TERMS

ELICIT: to cause or produce something as a reaction or response to a stimulus of some kind

ÉLITIST: the belief that some people or things are inherently superior to others and deserve preeminence, preferential treatment, or higher rewards because of their superiority

FARCICAL: a comic play in which authority, order, and morality are at risk and ordinary people are caught up in extraordinary goings on

SHAMANISM: a religion of northern Asia, in which shamans can intercede between humanity and powerful good and evil spirits

SHAMAN: somebody who acts as a go-between for the physical and spiritual realms, and who is said to have particular powers such as prophecy and healing

PROSCENIUM: the part of a theatre stage that is in front of the curtain

GLADIATORIAL: fighter in Roman arena: a professional fighter in ancient Rome who fought another combatant or a wild animal in public entertainments set in an arena. Often gladiators were criminals or enslaved men who were equipped variously with nets, nooses, swords, or other weapons.

WAYANG KULIT: puppet shadow plays: a form of Javanese and Balinese theatre consisting of shadow plays using puppets

BUNRAKU: Japanese puppetry: traditional Japanese puppetry using large wooden puppets, each worked by several puppeteers who are visible to the audience and with a separate narrator offstage

KABUKI: Japanese theatre: traditional Japanese drama in which male actors play both male and female parts

HANAMICHI: a raised platform leading to the central acting pavilion.

LITURGICAL: relating to worship: relating to religious worship or to a service of worship, especially the Communion

PLATEA: raised area with level top: a hill or mountain with a level top

PROMENADE: marching dance movement: a marching step or sequence in square or country dancing

EPOCH: start of a historically significant period: the beginning of a long period of history considered particularly significant

PRECEDENT: established practice: an established custom or practice

IMPETUS: push: something that provides energy or motivation to accomplish something or to undertake something

CHORAL: performed by choir: arranged for or performed by a chorus or choir
choral singing

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CHAPTER 3 – RESEARCH AREA

(THE USE OF GLASS AS A BUILDING MATERIAL)

3.1 INTRODUCTION

Glass has always intrigued man. Even the most sophisticated 20th century man is amazed and bemused by this solid, which he has been told, is really a rigid un-crystallized liquid. The product and the process used to manufacture it seem to smack of alchemy, for glass is nothing but coarse sand and soda ash transformed into smooth transparent forms. Glass is not easily described. The American Society for Testing and Materials defines glass as "an inorganic product of fusion, which has cooled to a rigid condition without crystallizing". Glass is a " semi or fully transparent hard , brittle, material made by igneous fusion of silica (usually sand) with an alkaline sodium of potassium salt and added ingredients such as lime, alumina, and lead oxide"[1]an inorganic solid amorphous substance made primarily of silica fused at high temperatures with borates or phosphates. The silica is generally obtained from sand, quartz or flint, and the alkali is generally soda-ash (obtained from seaweed) or potash (obtained from brushwood). The primary forms of soda used in glassmaking are soda ash (sodium carbonate) or caustic soda (sodium hydroxide). To these fundamental materials, other ingredients are added to obtain different effects. The ingredients have to be cooled with sufficient rapidity to prevent the formation of visible crystals. "Glass is called amorphous because it is neither a solid nor a liquid but exists in a vitreous, or glassy, state in which molecular units have disordered arrangement but sufficient cohesion to produce mechanical rigidity"[2]. Glass is cooled to a rigid state without the occurrence of crystallization; heating can reconvert glass to a liquid form. Glass largely is an open chain of silicon atoms with atoms of various oxides occupying the spaces between. It is this loose structure that permits transparency. Glass can also be translucent or opaque. Glass is strong, but it is also brittle and impervious to the natural elements. Glass is almost inert, though it can be attacked by hydrofluoric acid (HF), and it provides a high barrier to gas penetration. Glass has been made into practical and decorative objects since ancient times, and it is still very important in applications as disparate as building construction, housewares, and telecommunications

3.2 ORIGIN OF GLASS

Natural glass has existed since the beginnings of time, formed when certain types of rocks melt as a result of high-temperature phenomena such as volcanic eruptions, lightning strikes or the impact of meteorites, and then cool and solidify rapidly. Stone-age man is believed to have used cutting tools made of obsidian and tektites. According to the ancient-Roman historian Pliny (AD 23-79), who wrote in Naturalis Historica in 77 A.D.

Phoenician merchants transporting stone actually discovered glass (or rather became aware of its existence accidentally) on a beach near Belus in Asia Minor, roughly corresponding to present Asian Turkey around 5000 BC. Pliny tells how the merchants, after landing, rested cooking pots on blocks of nitrate placed by their fire. With the intense heat of the fire, while cooking the blocks eventually melted and mixed with the sand of the beach to form an opaque liquid.

3.3 EVOLUTION OF MAN-MADE GLASS

The earliest man-made glass objects, mainly non-transparent glass beads, are thought to date back to around 3500 BC, with finds in Egypt and Eastern Mesopotamia. In the third millennium, in central Mesopotamia, the basic raw materials of glass were being used principally to produce glazes on pots and vases. The discovery may have been coincidental, with calciferous sand finding its way into an overheated kiln and combining with soda to form a coloured glaze on the ceramics. It was then, above all, Phoenician merchants and sailors who spread this new art along the coasts of the Mediterranean. The oldest fragments of glass vases however, date back to the 16th century BC and were found in Mesopotamia. Hollow glass production was also evolving around this time in Egypt.

"After 1500 BC, Egyptian craftsmen are known to have begun developing a method for producing glass pots by dipping a core mould of compacted sand into molten glass and then turning the mould so that molten glass adhered to it"[4]. While still soft, the glass-covered mould could then be rolled on a slab of stone in order to smooth or decorate it. The earliest examples of Egyptian glassware are three vases bearing the name of the

Pharaoh Thoutmosis III (1504-1450 BC), who brought glassmakers to Egypt as prisoners following a successful military campaign in Asia.

There is little evidence of further evolution until the 9th century BC, when glassmaking revived in Mesopotamia. Over the following 500 years, glass production centred on Alexandria, from where it is thought to have spread to Italy.

The first glassmaking "manual" dates back to around 650 BC. Instructions on how to make glass are contained in tablets from the library of the Assyrian king Ashurbanipal (669-626 BC).

A major breakthrough in glassmaking was the discovery of glassblowing some time between 27 BC and AD 14, attributed to Syrian craftsmen from the Sidon-Babylon area. This discovery dates about 250 B.C. The long thin metal tube used in the blowing process has changed very little since then. Glass, however, did not replace shutters at the windows of Roman homes. The Romans tried but failed to cast transparent flat glass to enclose or ornament their homes. In the last century BC, the ancient Romans then began blowing glass inside moulds, greatly increasing the variety of shapes possible for hollow glass items.

The Romans did much to spread the glassmaking technology. With its conquests, trade relations, road building, and effective political and economical administration, the Roman Empire created the conditions for the flourishing of glassworks across Western Europe and the Mediterranean. "During the reign of the emperor Augustus, glass objects began to appear throughout Italy, in France, Germany and Switzerland. Roman glass has even been found as far afield as China, shipped there along the silk routes."[5] It was the Romans who began to use glass for architectural purposes, with the discovery of clear glass (through the introduction of manganese oxide) in Alexandria around AD 100. Cast glass windows, albeit with poor optical qualities, thus began to appear in the most important buildings in Rome and the most luxurious villas of Herculaneum and Pompeii.

With the geographical division of the empires, glass craftsmen began to migrate less, and eastern and western glassware gradually acquired more distinct characteristics. Alexandria remained the most important glassmaking area in the East, producing luxury glass items mainly for export. The world famous Portland Vase is perhaps the finest known example of Alexandrian skills. In Rome's Western empire, the city of Köln in the

Rhineland developed as the hub of the glassmaking industry, adopting, however, mainly eastern techniques. Then, the decline of the Roman Empire and culture slowed progress in the field of glassmaking techniques, particularly through the 5th century. Germanic glassware became less ornate, with craftsmen abandoning or not developing the decorating skills they had acquired. With the breakdown of the Roman Empire, glassmaking technology stagnated in Europe; in fact, it almost disappeared. Archaeological excavations on the island of Torcello near Venice, Italy, have unearthed objects from the late 7th and early 8th centuries which bear witness to the transition from ancient to early Middle Ages production of glass.

Towards the year 1000, a significant change in European glassmaking techniques took place. "Given the difficulties in importing raw materials, soda glass was gradually replaced by glass made using the potash obtained from the burning of trees."[6] At this point, glass made north of the Alps began to differ from glass made in the Mediterranean area, with Italy, for example, sticking to soda ash as its dominant raw material.

In the 11th century, German glass craftsmen developed a technique for the production of glass sheets. It was further developed by Venetian craftsmen in the 13th century. "Sheet glass could be made by blowing a hollow glass sphere and swinging it vertically, gravity would pull the glass into a cylindrical "pod" measuring as much as 3 metres long, with a width of up to 45 cm"[7]. While still hot, the ends of the pod were cut off and the resulting cylinder cut lengthways and laid flat. Other types of sheet glass included crown glass (also known as "bullions"), became relatively common across Western Europe. With this technique, a glass ball was blown and then opened outwards on the opposite side to the pipe. Spinning the semi-molten ball then caused it to flatten and increase in size, but only up to a limited diameter. The panes thus created would then be joined with lead strips and pieced together to create windows. Glazing remained, however, a great luxury up to the late middle Ages, with royal palaces and churches the most likely buildings to have glass windows. Stained glass windows reached their peak as the Middle Ages drew to a close, with an increasing number of public buildings, inns and the homes of the wealthy fitted with clear or coloured glass decorated with historical scenes and coats of arms.

In the middle Ages, the Italian city of Venice assumed its role as the glassmaking centre of the western world. The Venetian merchant fleet ruled the Mediterranean waves and helped supply Venice's glass craftsmen with the technical know-how of their counterparts

in Syria, and with the artistic influence of Islam. The importance of the glass industry in Venice can be seen not only in the number of craftsmen at work there (more than 8,000 at one point). A 1271 ordinance, a type of glass sector statute, laid down certain protectionist measures such as a ban on imports of foreign glass and a ban on foreign glassmakers who wished to work in Venice: non-Venetian craftsmen were themselves clearly sufficiently skilled to pose a threat. Until the end of the 13th century, most glassmaking in Venice took place in the city itself. However, the frequent fires caused by the furnaces led the city authorities, in 1291, to order the transfer of glassmaking to the island of Murano. The measure also made it easier for the city to keep an eye on what was one of its main assets, ensuring that no glassmaking skills or secrets were exported. Glassmakers of the island or Murano developed Soda Lime in about 1450, and Venetians termed this clear, thin glass **cristallo**. Despite attempts to keep their technology secret, it soon spread north over the Alps to Germany, France, Belgium and England. In the 14th century, another important Italian glassmaking industry developed at Altare, near Genoa. Its importance lies largely in the fact that it was not subject to the strict statutes of Venice as regards the exporting of glass working skills. Thus, during the 16th century, craftsmen from Altare helped extend the new styles and techniques of Italian glass to other parts of Europe, particularly France. "In the second half of the 15th century, the craftsmen of Murano started using quartz sand and potash made from sea plants to produce particularly pure crystal"[8]. By the end of the 16th century, 3,000 of the island's 7,000 inhabitants were involved in some way in the glassmaking industry. In England, where deforestation was a problem as early as the 15th century, glassmakers were required after 1615 to use coal instead of wood in the glassmaking process. The development of lead crystal has been attributed to the English glassmaker George Ravenscroft (1618-1681), who patented his new glass in 1674. He had been commissioned to find a substitute for the Venetian crystal produced in Murano and based on pure quartz sand and potash. By using higher proportions of lead oxide instead of potash, he succeeded in producing a brilliant glass with a high refractive index which was very well suited for deep cutting and engraving. In 1688, in France, a new process was developed for the production of plate glass, principally for use in mirrors, whose optical qualities had, until then, left much to be desired. The molten glass was poured onto a special table and rolled out flat. After cooling, the plate glass was ground on large round tables by means of rotating cast iron

discs and increasingly fine abrasive sands, and then polished using felt disks. The result of this "plate pouring" process was flat glass with good optical transmission qualities. When coated on one side with a reflective, low melting metal, high-quality mirrors could be produced. France also took steps to promote its own glass industry and attract glass experts from Venice; not an easy move for Venetians keen on exporting their abilities and know-how, given the history of discouragement of such behaviour (at one point, Venetian glass craftsmen faced death threats if they disclosed glassmaking secrets or took their skills abroad). "The French court, for its part, placed heavy duties on glass imports and offered Venetian glassmakers a number of incentives: French nationality after eight years and total exemption from taxes, to name just two"[9].

Flat glass for windows was still rare during much of the 17th and 18th centuries. Blowing a large glob of glass, removing it from the blowing iron and then rotating the glass quickly so it would spread and flatten, made small panes. Such glass had a dimple in its center, many air bubbles and a pattern of concentric circles, but it was transparent and effective in keeping out the weather. At the end of the 17th century, the French learned how to grind and polish cast glass to produce plate glass, but only the rich could afford it. It was not until the latter stages of the Industrial Revolution, however, that mechanical technology for mass production and in-depth scientific research into the relationship between the composition of glass and its physical qualities began to appear in the industry.

Coloured glass mosaics (stained glass) were introduced to Gothic construction. It was believed to have a divine nature because of its ability to transfuse coloured light into the inner sanctum of the Christian church. Glass did feature in other parts of society at this time, but it was more a symbol of wealth and prestige, generally available only to the upper classes. Medieval thinkers believed "Light is principle of order and value" and it was this belief in light that gave such respect and prestige in the family home. To date, stained glass has remained a prevalent building material in homes (front doors) and churches, although technological advancements have allowed for refinement.

A key figure and one of the forefathers of modern glass research was the German scientist Otto Schott (1851-1935), who used scientific methods to study the effects of

numerous chemical elements on the optical and thermal properties of glass. In the field of optical glass, Schott teamed up with Ernst Abbe (1840-1905), a professor at the University of Jena and joint owner of the Carl Zeiss firm, to make significant technological advances. Another major contributor in the evolution towards mass production was Friedrich Siemens, who invented the tank furnace. This rapidly replaced the old pot furnace and allowed the continuous production of far greater quantities of molten glass.

"Great strides were made in the manufacture of flat glass during the 19th century. Compressed air technology led to flatter, better glass panes. Controlled amounts of air were used to blow a large glass cylinder, which was slit lengthwise, reheated and allowed to flatten under its own weight"[10]. Large, relatively inexpensive lites of glass were produced in this manner. As a result of such technological advances, window areas that required 18 to 24 panes to enclose in 1730 could be increased dramatically and glass prices dropped by the 1860s, glass-enclosed "wind eyes" were commonplace in the humblest homes.

Plate glass, that wickedly expensive French product, also became commonplace by the end of the 19th century. Waterpower, then steam and then electricity made the grinding and polishing of heavy glass plates faster and easier. By the 1860s, smart stores and office buildings in Europe and North America glistened with plate glass. France, Belgium and Germany monopolized the production of the product until 1883, when the Pittsburgh Plate Glass Company became the first successful manufacturer of the product in the United States. By 1895, the company could produce 20 million square feet of plate glass a year, and imports from Europe fell sharply.

With the 20th century came an era of revolutionary technology. Machines were developed, improved and perfected to produce endless ribbons of sheet (window) glass, to produce plate glass polished and ground simultaneously on both sides and to produce float glass on a bed of molten tin. "Also developed were processes to strengthen glass through thermal and chemical tempering, to add tints to glass for reduced heat transmission and glare and to coat glass with transparent metal and metal oxide films that reflected heat or conducted electricity"[11]. And products marrying these processes and

developments were created to help make life more convenient, more comfortable, safer and more beautiful.

Glass has been made to be bomb proof, bulletproof, fire proof and can restrict or even barrier against solar and thermal entry. Glass such as Electrochromic, Photochromic ot Thermochromic can change color under different light or thermal conditions, Liquid crystal technology which restricts light or Prismatic Glazing which reflect light entering the building. All of these demonstrate the development glass has made over the last 100 years; soon it may be possible for entire structures to be made from glass.

In retrospect, the romance of glass is not an Egyptian producing a bottle for a Pharaoh or window glass being made from a cylinder, a pane at a time, in a one-man glass house. "The true romance of glass is the story of the reasonable cost for use in architecture, transportation, industry, science and the home. Billions of people now benefit because technology has made glass a versatile, easy-to-use miracle"[12].

3.4 PROPERTIES OF GLASS

Glass has many facets; it is strong or brittle, clean, transparent or reflective, warm or cool, decorative, translucent, an insulator, and so on. These characteristics are continuing to expand due to scientific research

Different types of glass have different composition of raw materials which makes the properties of vary according to the composition of that particular glass. However, some properties are common to majority of glass types

- Glass has a high melting point and does not shrink or expand greatly with changing temperatures.
- Depending on the composition, some glass will melt at temperatures as low as 500° C (900° F); others melt only at 1,650° C (3,180° F).
- The tensile strength of glass is normally between 2,745 and 5,500 N/sq cm (4,000 and 8,000 lbwt/sq in), and can exceed 68,650 N/sq cm (100,000 lbwt/sq in) if the glass is specially treated.

Relative density ranges from 2 to 8 or from less than that of aluminium to more than that of steel. Similarly wide variations occur in optical and electrical properties.

- Glass is strong, but it is also brittle. This means that if it contains any defects such as scratches, then when it is stressed cracks will propagate and it will break. By making thin fibres of glass with perfectly smooth surfaces, the inherent strength can be exploited and strong glass reinforced fibre composite materials can be made. Toughened window glass is produced by incorporating compressive stresses in the surface layers, so that even if the glass is stressed any surface cracks remain under compression and therefore are less likely to propagate.
- Glass is almost inert, though it can be attacked by hydrofluoric acid (HF), concentrated phosphoric acid (when hot, or when it contains fluorides), hot concentrated alkali solutions and superheated water. Hydrofluoric acid is the most powerful of this group, it attacks any type of silicate glass. Other acids attack only slightly; the degree of attack can be measured in laboratory tests but such corrosion is rarely significant in service for acids other than hydrofluoric and phosphoric.
- Glass provides a high barrier to gas penetration, making it excellent for bottles and other containers.
- When ordinary glass is subjected to a sudden change of temperature, stresses are produced in it that render it liable to fracture; by reducing its coefficient of thermal expansion
- Glass is non-porous, non-absorptive and impervious to the common elements and many harsh chemicals and liquids.
- Glass is exceptionally resistant to abrasion and surface scratches. It is one of the best electrical insulation materials, yet can be treated to conduct electricity.
- Glass has lower head conductivity than most metals and can possess a very low, zero or even negative coefficient of expansion.
- Glass has such a high dielectric strength that it is difficult to measure, and the results can be interpreted with the least certainty.

3.5 COMPOSITION OF GLASS

This natural glass is composed of three elements of the earth-sand, soda and lime. These same elements in varying forms also make up the basic composition of manufactured

glass products ranging from containers and glassware to windshields and windows for high-rise commercial buildings. About 50 other chemical elements are used in modern glassmaking, in major and minor ways, to affect color, viscosity or durability, or to impart some desired physical property. But nature's original ingredients are still basic elements in the formulation of glass.

a.) Water Glass and Soda-Lime Glass

"Glass of high soda content can be dissolved in water to form a syrupy fluid."[13] Known as water glass, it is used commercially for fireproofing and as a sealant. Most manufactured glass is a soda-lime composition used to make bottles, tableware, lamp bulbs, and window and plate glass.

b) Lead Glass

Lead in the form of lead oxide, may be used to replace lime, and is introduced to increase brilliance, density and index of refraction. Lead glasses included optical and ophthalmic glasses and the finest stemware and art objects. The fine-quality table glass known as crystal glass is made from potassium-silicate formulas that include lead oxide. "Lead glass is heavy and has an enhanced capacity to refract light, which makes it suitable for lenses and prisms, as well as for imitation jewels."[14]. Because lead absorbs high-energy radiation, lead glasses are used in shields to protect personnel in nuclear installations.

c) Borosilicate Glass

Boron, substituted in whole or in part for the silica, increases the refractive index, deepens the color produced by various other coloring materials, and greatly reduces the coefficient of thermal expansion. Noted for its durability and resistance to chemical attack and high temperatures, borosilicate glass is widely employed for cooking utensils, laboratory glassware, and chemical process equipment.

d) Colour

Impurities in the raw materials affect the colour of glass. For a clear, colourless substance, glassmakers add manganese to counteract the effects of iron traces that produce greens and browns. Glass can be coloured or tinted by dissolving metallic oxides, sulphides, or selenides in it. Other colourants may be dispersed as microscopic particles.

e) Miscellaneous Ingredients

Typical glass formulas include broken waste glass of related composition (cullet), which promotes melting and homogenization of the batch. Fining agents such as arsenic or antimony are often added to cause the release of small bubbles during the melting.

3.6 GLASS AS A BUILDING MATERIAL

Architecture is a process of creation where the architect, using available methods, creates a space that is useable, technically and aesthetically satisfying and complies with the demands and the purpose designated for each project. In this process the use of glass is among the most important techniques used. Traditionally glass has been used for its clarity and rigidity which prevent wind, cold and dust to get inside a building but allow light to penetrate into internal spaces as well as to give a clear view of external space. With time the desire to satisfy modern needs caused the development of glass into a tough industrial product with many additional characteristics and possibilities. Curved glass began to be used as a method available to the architect with industrialisation and the development of towns in the 19th century. The technology of curving glass developed with demand. Curved glass was primarily used for conservatories and shop windows giving a special sense of space and a friendly atmosphere.

The technology and use of curved glass developed further with the introduction of curved glass in the automotive industry. In architecture, however, the relatively low quantity (occasionally unique pieces) required a process that required the building of special moulds for each case, meant that the cost of production remained high. The development of flexible moulds and the introduction of advanced techniques in glass production means, however that cost is less quantity related and thus much more attractive.

The amount of glass used in buildings increases constantly. On many a modern building the entire structure is covered in glass. Demand for ever higher quality, an ever greater variety of products and the desire for ever more unique and complicated pieces that will impress, also drives the developments in the industry.

In the future the use of glass is surely to increase further, both for exterior and interior of buildings. Techniques and aesthetics which are ever more important are ever easier to achieve with new technology in glass production. Curved glass surfaces give us a new and special view and display technical possibilities.

When selecting the type of glass used for buildings a number of different characteristics should be evaluated. Some of the glass properties to consider are as follows:

Solar control

Solar energy can be pleasant and utilizable in many cases, but especially in buildings, it represents a major source of overheating and unpleasant glare. Glass industry has found the answer in several solar controlling glasses. The selection of a solar control glass is of vital importance in determining the comfort of the occupants, running costs of air-conditioning systems and the environmental impact of energy consumption, which could be avoided by using passive solar control. When solar radiation in the form of light and heat strikes a glass window it is partly reflected, partly transmitted and partly absorbed. Solar control glasses reduce the solar radiant light and heat energy, transmitted through the glass, by increasing the amount absorbed and/or reflected.

Solar control glass, usually either body-tinted (absorbing) or coated (reflecting), is used to reduce unwanted solar radiant light and heat energy transmitted through glass. The Solar Heat Gain Coefficient (SHGC) is the best measure to determine how well a product blocks heat caused by sunlight. A similar, but much less precise measure of heat gain is the Shading Coefficient (SC).

Acoustic insulation

The need to restrict sound arriving from the external environment means that glass should be able to shield and insulate the internal spaces of a building. Glass type is the major factor influencing the passage of sound. The most common types of glass used are

laminated and insulating glass (Double glazed). Laminated glass incorporates a special acoustic PVB interlayer, which absorbs some of the incident sound energy, reducing its passage. Better sound insulation can also be achieved with double-glazed glass in which vacuum-sealed inner spaces and some gases affect sound insulation and provide acoustic stability.

Thermal insulation

Thermal conductivity is a measure of the ability to conduct heat through the body of that material. In an opaque material, thermal conductivity can be measured straightforwardly. In a transparent material such as glass, any measurement of conductivity becomes complicated by the fact that glass also conducts heat internally by radiation. Values for conductivity rise with rising temperature and above 400°C the contribution from radiative transfer is appreciable. Radiative transfer depends on the thickness of the sample. Because of this complication, published figures for glass thermal conductivity show considerable disagreement. And because of this uncertainly, thermal conductivity in glass is not used extensively as a design parameter. The U value is a measure of the rate of heat loss of a building component. It is expressed as watts per square metre, per degree Kelvin, W/m2K. Lower U-Values are achieved by multiple glazing layers, gases and the use of low-e coatings.

Strength

Strength of glass is only slightly affected by composition but is highly dependent on surface condition. Commercially produced glass ware can acquire small nicks and scratches in the course of manufacture and later in use. Any applied stress will be concentrated at these points of damage with the result that the stress at these points will be increased above the amount of the applied stress. Glass is subjected to different types of environmental and human loads, which can cause glazed surfaces to malfunction or break. Since each load has a specific impact on glass, with different calculation formulas, it is important to understand each of these phenomena in order to choose the appropriate glass.

Visual appearance

When we talk about visual appearance we have in mind the color of glass surface. Thanks to the latest manufacturing processes, glass can be made available in several colors. When we combine single sheets of glass in laminated or insulated units, they typically change in overall color and appearance. Glass color appearance can be also conditioned by several environmental factors such as sunlight (midday sun or sunset), reflected sky and clouds.

Action of forces on a material

Push, pull or twist a piece of glass hard enough and it will bend or stretch. Not very much, admittedly, but some bending or stretching is possible. Watch the reflections in a large window when a strong wind is blowing on it and you can observe the way the window bends from the force of the wind. Glass is an unusual material in this respect, not because it bends or stretches—most materials do—but because it returns exactly to its original shape when the bending or stretching force is removed. This characteristic of glass classifies it as a perfectly elastic material. If you apply an increasing force, the glass breaks when the force reaches the ultimate strength of the glass. But at any point short of breakage, the glass will not deform permanently.

To be precise, glass must be classified as nearly perfect elastic material because under some conditions permanent deformation, or plastic flow, and to be produced. There are three types of forces to be considered:

A tensile force exerts a pull on the material (a mild tensile force exerts a pull on the material; a severe tensile force pulls the material apart).

A compressive force acts to squeeze the material.

A shear force acts on the material in a manner similar to a pair of shears to slide one part of the material in one direction and another in the opposite direction.

Tensile forces are the most important in glass because they give rise to tensile strain within the glass and glass breaks only from tensile tension. (The terms stress and strain are sometimes confused. In fact, they are used interchangeably at times as if both represent the same phenomenon.)

3.7 SAFETY GLASS

Glass can be classed into three main categories based on their means of strengthening:

a) tempered safety glass
b) laminated safety glass
c) insulated glass units

3.7.1 TEMPERED GLASS

Glass that is strengthened through the process of heating and then cooling the surface rapidly is known as Tempered Glass. It is a pre stressed glass and is also known as toughened glass, or tempafloat glass. Tempered safety glass is made by heating high quality float glass up to the softening point and then rapidly cooling it with a precisely controlled uniform blast of cold air which toughens the glass' surface compressive stress whilst retaining its original optic quality. This process creates surface compression and tensile strength that causes glass to resist breakage, yet disintegrate into small pieces if a break occurs. Fully tempered glass must have a surface compression of 10,000 psi. Tempered safety glass can withstand impacts five times stronger than ordinary glass. If, however it is broken, it shatters into small, blunt pieces, preventing serious injury.

Manufacturing processes

In the "heat-treatment" process the key procedure is application of a rapid air quench immediately upon withdrawal of hot (approx. 1200 ° F) glass from the "tempering furnace." The immediate and sustained application of an air quench produces the temper. As air direction against hot glass from arrays of fixed, reciprocation or rotating blast nozzles, it is important to extract heat uniformly from both surfaces (uneven heat extraction may produce bow or warp) and to sustain the quench long enough to prevent

reheating of the glass surfaces from the still-hot glass core. A quenched condition becomes stable when the glass is reduced to a temperature of approximately 400-600 ° F.

There are two principal manufacturing methods for producing heat-treated glass. One process heat treats the glass in a horizontal position while the second method moves the glass through the furnace in a vertical position with each light of glass held by metal tongs.

3.7.1.1 PROPERTIES OF TEMPERED GLASS

Strength

Under wind pressure, tempered glass is approximately four times as strong as annealed glass. It resists breakage by small missiles traveling approximately twice as fast as missiles which break annealed glass. "Toughened glass has the further advantage of increased bending and impact resistance qualities and tolerance to temperature change (150K temperature difference, and up to 300° C compared with 40° C for annealed materials. It is also unaffected by sub-zero temperatures."

	Annealed Glass	Tempered Glass
Typical Breaking Stress (large light 60 sec. load)	6,000 psi	24,000 psi
Typical Impact Velocity Causing Fracture (1/4" light 5 gm missile, impact normal to surface	30 ft/sec	60 ft/sec

Table 3.1 strength of tempered and annealed glass

Sourced from www.glassonweb.com

Safety

Fully tempered glass is used in many applications because of its safety characteristics. Safety comes from strength and from a unique fracture pattern. Strength, which effectively resists wind pressure and impact, provides safety in many applications. When fully tempered glass breaks the glass fractures into small, relatively harmless fragments.

This phenomenon called "dicing," markedly reduces the likelihood of injury to people as there are no jagged edges or sharp shards.

High shock resistance

Tempered glass shock resistance is up to five times better than ordinary glass.

High resistance to uniformly distributed compression

Tempered glass has a high resistance to uniform pressure and can thus be used on tall buildings where one must consider the impact of high wind pressure.

High heat shock resistance

Tempered glass can withstand radical change of temperature of up to 200 degrees centigrade, compared to 70 degrees for ordinary float glass.

Clarity

The tempering process does not affect the clarity and transparency of the glass.

3.7.1.2 USE OF TEMPERED GLASS

Fully tempered glass is used traditionally in place of other glass products in applications requiring increased strength and reduced likelihood of injury in the event of breakage. The building industry, motor vehicle industry and certain manufacturing industries find tempered glass is effective and economical in a wide range of applications.

Fully tempered glass can satisfy federal, state and local building code requirements for safety glazing in such applications as doors, side lights, shower and tub enclosure, and interior partitions. It is also used in storm doors, patio-door assemblies, and escalator and stairway balustrades. As a glazing product it is used in windows and in spandrel areas (for wind pressure, small missile impact and thermal stress resistance). Special building applications include sloped glazing, racquetball courts, skylights, and solar panels. Any conditions or requirements imposed in the applicable safety glazing laws and building codes limiting such special uses should be determined prior to glazing.

3.7.2 LAMINATED GLASS:

Laminated glass is safety glass that has been manufactured by adhering two or more sheets of glass together with a flexible interlayer. Laminated glass consists of a tough protective interlayer made of polyvinyl butyral (PVB) bonded together between two panes of glass under heat and pressure. Once sealed together, the glass "sandwich" behaves as a single unit and looks like normal glass. Annealed, heat strengthened or tempered glass can be used to produce laminated glass. There are two types of laminated glass: PVB and resin laminated glass:

PVB laminated glass is two or more sheets of glass which are bonded together with one or more layers (PVB) under heat and pressure to form a single piece. PVB Laminate is a safety glass made by a heat and pressure process that laminates two or more sheets of glass with a flexible interlayer between them. Generally this interlayer is 0.38mm thick, although for auto or extra strength use, a double interlayer of 0.76mm thick is used. The safety aspects of this glass result from the PVB layer which prevents the glass disintegrating if broken and also acts as a preventative barrier against penetration. By using a tinted interlayer, laminated glass can be used to reduce heat transmission. The plastic properties of the interlayer in PVB laminated act with a sound dampening effect and can provide sound control equivalent to that of ordinary glass of twice the thickness

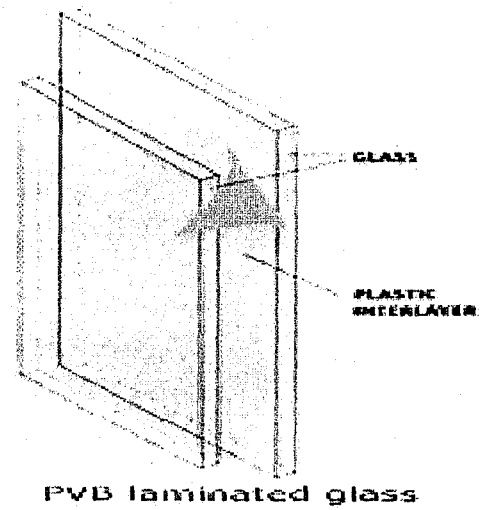

Figure 3.1 PVB laminated glass

Sourced from www.glassonweb.com

Resins laminated glass is manufactured by pouring liquid resin into the cavity between two sheets of glass which are held together until the resin cures.

3.7.2.1 PROPERTIES OF LAMINATED GLASS

Strength

The layer of PVB within the glass gives it added strength such that when hit with a very large object, the glass may crack but it will not shatter i.e. the fragments of the glass will remain in place.

Safety

The toughness and resiliency of laminated glass makes it an excellent safety glazing. In vertical or sloped applications, laminated glass can resist penetration from impact. If the glass is broken, fragments will adhere to the PVB, reducing the risk of personal injury and property damage. When subjected to accidental human impact, the bond between the glass and interlayer combine to absorb the force of the impact, resisting penetration of the laminate. Should the impact be sufficient to break the glass, the resulting fragments typically remain intact, firmly adhered to the interlayer. This important characteristic significantly reduces the likelihood of serious injury, qualifying laminated glass as a Grade A safety glass.

Security

Laminated glass offers greater protection for people and property over other glass products. This is done by providing an effective barrier when under attack. The standard two-ply construction provides resistance to penetration when subjected to attempted force entry. In multi-ply configurations, laminated glass can even resist bullets, heavy objects, or small explosions. If attacked, the glass will tend to remain in the opening, keeping wind and rain out of the building until it can be replaced at a convenient time.

Sound control

In many instances laminated glass is often overlooked as an acoustic glass. For most applications, laminated glass provides an effective, low cost method for reducing the

transmission of noise through glass. This is achieved through the 'viscoelastic' properties of the interlayer which dampens the shear performance, which makes it effective sound control product.

Heat and Glare Control

While it is desirable to allow more natural light into our homes and buildings, more light often means more heat entering the interior. Laminated glass with a tinted interlayer can reduce heat gain by absorbing this radiated heat while simultaneously cutting down the amount of glare that occurs with high levels of natural light. The underlying benefit is lower costs for cooling the interior.

Easy handling

Laminated glass can be cut with the usual glass cutting tools. The outer sides of laminated glass are sheets of high quality float glass, which can be grinded, etched, bent or sandblasted in the usual way.

UV Elimination

PVB Laminated glass protects expensive curtains, furnishings and carpets from the damaging effects of short-wave ultra-violet radiation. The PVB interlayer filters the sun eliminating up to 99% of UV rays while allowing the important visible light to pass through.

Low visible distortion

Due to the controlled nature of the laminating process, facades glazed with laminated, annealed glass avoid the risk of visible distortions, providing significantly sharper reflections.

3.7.2.2 USES OF LAMINATED GLASS

Laminated glass is the only glass to provide durability, high-performance and multi-functional benefits while at the same time preserving the aesthetic appearance of the glass. Laminated glass furnishes solutions to many architectural design problems and offers increased protection from the effects of disasters such as hurricane, earthquake and bomb blast. This characteristic makes it particularly suitable where it is important to ensure the resistance of the whole sheet after breakage such as: shop-fronts, balconies, stair-railings, roof glazing

There are several categories of laminated glass. They include:

- **Laminated anti-bandit glass:** this is the most suitable material for providing complete security in protective glazing systems. "Anti – bandit glass can be made with two glass layers of different glass thicknesses bonded with PVB foil or with three or more glass layers of different glass thicknesses bonded with standard or reinforced PVB foil"[15]. The resilient PVB interlays absorb all the shock waves from impact which may occur from heavy objects. The PVB interlay also prevents the collapse of the pane and the flying of loose fragments, should the glass sustain an attack. Even after a sustained attack, the glass would still provide visibility and protection from elements. "Additional security can be achieved by bonding the glass to the framing members so that the frame and the glass cannot be separated during the attacks."[16]

- **Bullet resistant glass:** a build up of multiple layers of laminated glass (overall thickness between 20 – 50 mm) is required to protect against gun shots. This type of glass usually incorporates up to four layers of glass, some of different thicknesses interlaid with PVB. Even after an attack barrier protection and visibility is still maintained.

- **Fire resistant glass:** "fire resistant glass can be built in two ways; by laminating a combination of Georgian wired glass and float glass (or safety, or security glass) with a PVB interlay"[17]. The other way is to incorporate a transparent intumescent layer between pre-stressed borosilicate glass sheets, which when heated swells to form an opaque fire resistant barrier. Fire resistance of up to 2h can be achieved.

- **Sound control glass:** laminated glass provides an increased degree of sound control and a more consistent acoustic performance when compared with ordinary glass. "It dampens the coincident effect found in window glass, thus offering better sound reduction at higher frequencies, where the human ear is particularly sensitive"[18]. For effective reduction in sound transmittance, the cast in place type of lamination is particularly effective.

- **Wired glass:** is a type of glass with a wire framework designed to reduce the danger of flying glass. "Although this glass is no stronger than the same glass without the wire mesh, the wire not only retards the extension of cracks but holds the fragments together to keep them from flying into long jagged slivers"[19].

3.7.3 INSULATED GLASS UNITS

Insulating glass is a glazed unit composed of two or more glass panes separated by spacers filled with dehydrated air or gas. The sheets are connected by a spacer, using sealants around the perimeter to reduce water vapor penetration. The whole unit is hermetically assembled by a secondary edge seal which gives structural robustness to the insulating glass. The spacer contains a desiccant which absorbs humidity from within the air space. The insulating glass unit (IGU) is made manually or with an automatic plant. The type of glass, the type of spacer, and the type of gas used in the space contribute to the overall insulating efficiency of the glass.

An insulated glass assembly consists of two sheets of glass separated by an air space, and sealed together into a unit.

IG units can be produced with one or more spacer bars as required. It can also be combined with Georgian Bars (decorative divided glass), to give that special look.

"The main purpose of these spaces is to improve the insulating characteristics of the IG units either against heat (thermal insulation) or against noise (noise reduction). In certain cases dry air is substituted with a specific gas."[20]

Figure 3.2 insulated glass unit

Sourced from the glass construction manual

3.7.3.1 PROPERTIES OF INSULATED GLASS UNITS

The properties of insulated glass are dependent on the following:

- The glass itself
- The type of gas used in the air gap
- The type of spacing material that holds the panes apart
- The material the window frame itself is made of.

The glass used in the manufacture of these windows may be coated or uncoated. Coated glass is typically called "Lo E", which means low emissivity. The coating is an extremely thin layer of metallic oxide that decreases the transmission of heat through the glass. Some of these coatings also decrease the passage of ultraviolet light (UV) which is notorious for causing fading in furniture and carpets.

The gas used in the space between the panes is dehydrated air in the least expensive panes, and argon and/or krypton gas in the highest quality panes. Argon and krypton gas have qualities that decrease the movement of heat through the space, giving improved efficiency. However, these gasses increase the manufacturing cost of the windows.

The third critical factor in the efficiency of insulating glass is the spacing material. Less efficient windows use aluminum as a spacing material... a poor choice since aluminum is a very heat-conductive material. Various companies have come up with better alternatives, such as stainless steel or composite metal/rubber combinations.

The final component actually has nothing to do with the glass at all. It is the material composing the window frame. Solid metal frames and tracks produce a net energy loss, since the metal pulls heat out of the house. This effectively negates much of the value of the insulated glass. Most new windows are made either from wood, vinyl-clad wood, or metal with an insulating "break" between the inside and outside parts, resulting in less heat transfer to the outside.

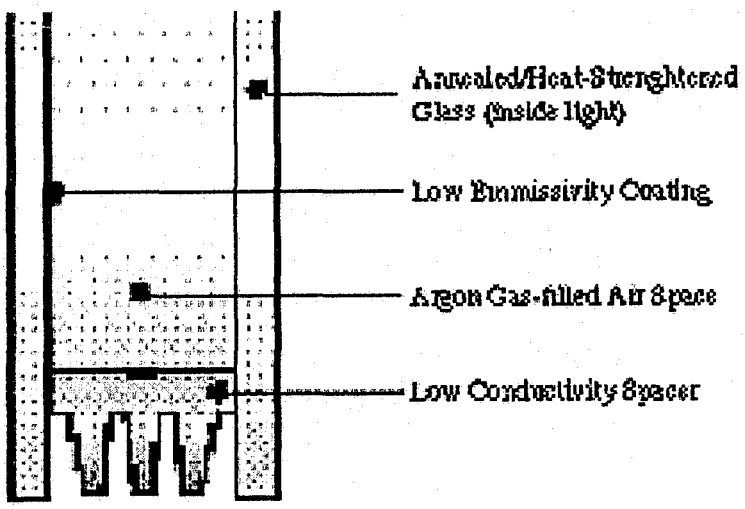

Figure 3.3 a section through an insulated glass unit

Sourced from www.andersenwindows.com

The amount of noise that penetrates the glass is dependent on the type of glass used. The following types of glass can be used making insulated glass units:

- normal float glass
- safety glass (laminated or tempered)
- hard coat reflective glass

COMPONENTS	NOISE REDUCTION
- Single glass sheet	24 dB
- IG unit 4/12/4 mm	33 dB
- IG unit 4/12/4 mm with special gas	35 dB
- IG unit, with laminated glass (4-1.52-4)/18/8 mm and special gas	48 dB

Table 3.2 the average noise reduction of windows using various types of glass

Sourced from: www.solutia.com.

3.7.3.2 USES OF LAMINATED GLASS UNITS

With the average city noise level ranging around 65dB - 75dB, the maximum recommended noise level at hospitals of 38 dB could never be reached, or even be approximated, without the use of IG units. The use of IG units also ensures safety. All the glass used is of safety glass material, which is achieved either by heat strengthening or the use of laminated glass. Hence, IG units for windows, if combined with the right hardware, provide, next to thermal insulating properties, also a safety aspect. Or, become even burglar proof.

IG units, with glass sheets of differing thickness, can also effectively avoid resonance.

3.8 GLASS BLOCKS:

Glass blocks have long been an architectural feature in buildings of all sizes and types, moving in recent years from their utilitarian beginnings in commercial and industrial buildings into widespread popularity in residential construction

"Glass blocks are hollow units which consist of two sections melted and pressed together, creating a sealed air cavity."[21] "The doughy mass is subsequently moulded into shells. Two shells are required for each block."[22] Both surfaces of the glass block can be made smooth and transparent, or very ornamental and almost opaque. Glass blocks can be obtained in different sizes, coated on the inside or outside uncoated, or made of coloured glass.

3.8.1 PROPERTIES OF GLASS BLOCKS:

Glass blocks have the following properties:

- they are fire resistant (up to G 60 or G 120)
- they cannot be used in a load bearing capacity, but they carry their own weight.
- they have good sound and thermal insulation
- they have high light transmittance (up to 82%)
- they posses an enhanced resistance to impact and breakage.

Figure 3.4 A Glass block

3.8.2 ADVANTAGES OF GLASS BLOCK

Glass blocks have the following advantages:

Wide range of design options

Straight, curved, and discontinuous curved walls are available through selection of glass block sizes. Patterns permit light control and use of transparent or non-transparent glass. A colorful atmosphere can be created by choosing colored blocks.

Energy-saving

"The inside of each glass block is a near-vacuum with a pressure of 0.3atm. This provides the glass block with a higher heat insulating value than the double glazed glass, qualifying the glass block as an energy-saving building material"[23].

Amenity

The glass block creates an agreeable living environment by transmitting, refracting, or reflecting light. The transparent glass block permits a view of the surrounding landscape, thereby avoiding a feeling of entrapment. Moreover, the glass block creates a quieter space by reducing noise.

Safety

A properly installed glass block wall is normally reliable. It is wind- and earthquake-resistant, and also offers protection against crime.

Safety

A properly installed glass block wall is normally reliable. It is wind- and earthquake-resistant, and also offers protection against crime.

Maintenance-free

The easy to clean and condensation-free glass block facilitates building maintenance. If cracked a glass block is readily replaceable.

3.9 FOAM GLASS:

Is a type of glass made by adding a foaming agent to finely ground glass and heating the mixture to the softening point. At that point the foaming agent releases a gas that produces a multitude of small bubbles within the glass. The resulting glass has a very low density but a high compressive strength and dimensional stability, making it particularly suitable for thermally and acoustically insulating construction materials. Foam glass can be made from recycled glass.

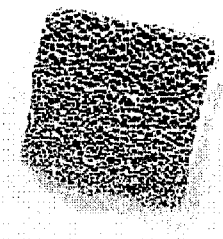

Figure 3.5 foam glass

3.9.1 Properties of foam glass

It is a lightweight, extremely fine-pored expanded glass with millions of hermetically sealed pores. Since no diffusion can take place, the material is watertight and achieves an efficient barrier against soil humidity.

Besides the outstanding mechanical and thermal properties of the product, foam glass manufacture is an exemplary process for waste recycling on an industrial basis. Foam glass can be manufactured fully out of waste glass, with only a minimum of virgin additives.

Foam glass grain is the product of choice wherever a finely grained, free-flowing bulk material is required. It is especially suitable for thin-walled thermal insulations, such as for window frames, cement bricks and insulating plasters.

Foam glass is extremely light. Its bulk density is partially adjustable by the expansion process parameters, in the range of 120 to 250 kg/m3, the material density 250 to 500 kg/m3.

Foam glass has high compression strength, is durable against degradation, fire-resistant, odourless and has excellent insulating properties.

Physical Data

Composition:

Glass (recycled or virgin)n)	98 % wt
Additives (inorganic salts)	2 % wt

Thermal Conductivity:

Size (mm)	Layer height (cm)	Density (kg/m3)	Thermal Cond. (W/m X K)
2/4	4	300	0.073G
4/8	4	294	0.092
8/16	8	254	0.084
10/50	25	244	0.072

Compression Strength:

Size (mm)n)	Compr. strength (kN/m2)
10/50	43'500

Table 3.3 properties of foam glass

3.10 GLASS AS AN AGGREGATE:

Glass is used as an aggregate in the composition of glass reinforced concrete (GRC). "GRC can be summarized as an ideal marriage between brittle materials, cement, sand and glass to produce a tough composite."[24] "The material is a composite of cement, sand, and alkali resistant glass fibre in proportions of 40 – 60% cement, 20% water, up to 25% sand, and 3.5 – 5% glass fibre by weight."[25] The great advantage of cement reinforced with glass fibres is the ability to produce elements much thinner, typically 10mm, and much lighter than is possible with traditional steel reinforcement.

3.10.1 PROPERTIES OF GRC:

GRC is similar to reinforced concrete in the following ways

- weather resistance
- non combustibility
- low thermal movement
- easy maintenance
- resistance to fungus and insects.

It has the following advantages over reinforced concrete

- high strength to weight ratio, hence thinner sections can be used
- availability in a wide range of surface finishes
- ease of forming into a variety of shapes
- combines easily with other materials to form insulated semi-structural elements of great strength.

A piece of GRC in flat sheet form 6mm thick weighs about 12 kg/m^2.

3.10.2 USES OF GRC:

To date, GRC technology has been used in the following applications; large cladding panels, roofing, permanent and temporary formwork, fire doors and partitions, cable ducting, corrugated sheeting, street furniture.

We are blessed to have architects and designers who are acknowledging the need for more structural security, they not only are improving the security needs of our society, they are continuing to be undaunted by the concerns to cut back on glass walls and large windows. Instead they are examining exceptional methods to continue in the same flamboyant vain and allow Mother Nature's light source to continue to shine in and radiate the beauty of this world. Terrorism is not changing their quality of architecture and certainly they have chosen qualified glass protection methods and technology to understand the components of glass and its weaknesses, to work hand in hand on the security and design needs of our explosive world today.

In all the cases studies carried out, adequate ventilation was a problem for the auditoriums, especially those housing a large number of people. One of the main characteristic of glass is its transparent nature, which allows natural light penetrate into an area. As a solution to this problem, the design of the auditorium of the proposed theatre would be a reinforced concrete frame, with glass as the body of the structure. The body would consist of transparent windows, and tinted insulated glass units as the remaining part of the body, which would drastically reduce heat and glare.

3.11 DEFINITION OF TERMS

ALCHEMY: transforming or enchanting power: a power supposedly likes alchemy, especially of enchantment or transformation

AMORPHOUS: without shape: without any clear shape, form, or structure

BRITTLE: hard and breakable: hard and likely to break or crack

BULLION: mass of metal: any metal in the form of an unshaped mass

SELENIDES: selenium compound: a compound of selenium combined with another element, for example silver selenide

CULLET: glass to be recycled: broken or waste glass returned for recycling

VISCOELASTIC: viscous and elastic: used to describe asphalt and many polymers that exhibit both viscous and elastic properties when deformed

RESILIENT: elastic: able to spring back quickly into shape after being bent, stretched, or deformed

INTUMESCENT: swelling of compound: the swelling of a crystalline compound on heating, often with the release of water vapour

SLIVER: splinter: a thin piece of something that has been split, cut, or broken off

JAGGED: with sharp points: having sharp protruding parts or points

HERMETICALLY: airtight: so tightly or perfectly fitting as to exclude the passage of air

NEGATE: invalidate something: to officially declare something to be invalid or render it invalid

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CHAPTER 4 - CASE STUDIES

4.0 INTRODUCTION

When carrying out a research project, studies of existing related topics is of great importance as it acquaints the researcher with the character of similar existing ones. The merits, demerits, choice of material, and facilities contained in each case study would enlighten the researcher on which path to follow in carrying out his design. On this account, four national case studies were carried out. Each case study is accompanied with necessary illustrations.

4.1 CASE STUDT 1: NATIONAL THEATRE IGAMU LAGOS.

4.1.1 LOCATION

4.1.2 HISTORY

The idea for the National theatre was initiated by General Yakubu Gowons' administration to host the world during the African festival of arts and culture in 1977 (FESTAC '77). The design for the existing theatre was taken from the palace of culture and sports in Varian, Bulgaria. The concept of the building is a military cap. The contract for its construction was signed on April 24, 1973. A Bulgarian construction company called technoexportsroy was the main contractor.

4.1.3 FACILITIES PROVIDED

The following facilities are contained in the National theatre

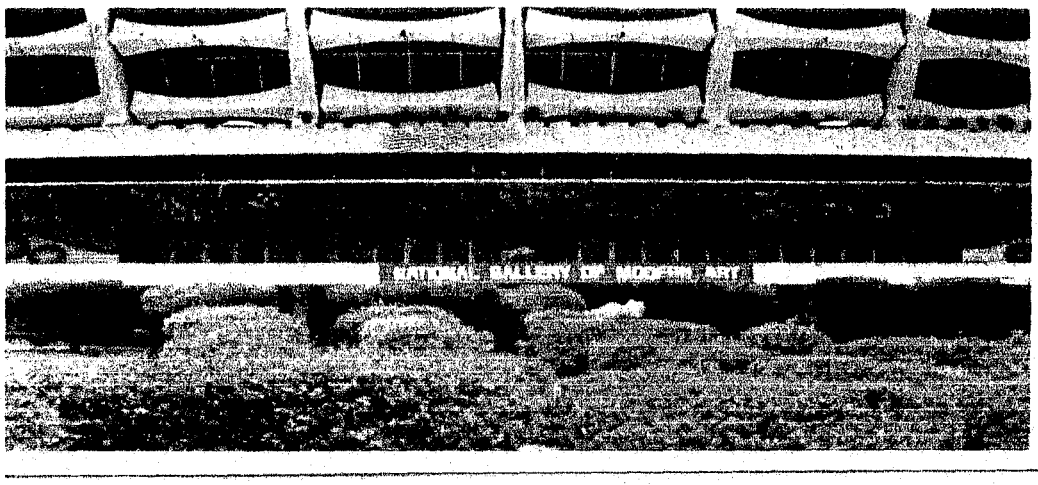
- A main auditorium with a seating capacity of 5000 people
- Two cinemas halls each with a seating capacity of 676 people
- Two exhibition halls each measuring about 1800m^2
- A press conference hall with a seating capacity of 80 people.
- A VIP reception area with a seating capacity of 30,
- A VIP lounge with a seating capacity of 500 people.

4.1.4 MERITS

- Several activities can take place at the same time without sequential interference
- The main auditorium can be adapted for multi functional use

4.1.5 DEMERITS

- The parking space provided are not defined
- The basement parking space provided for staff are two much.



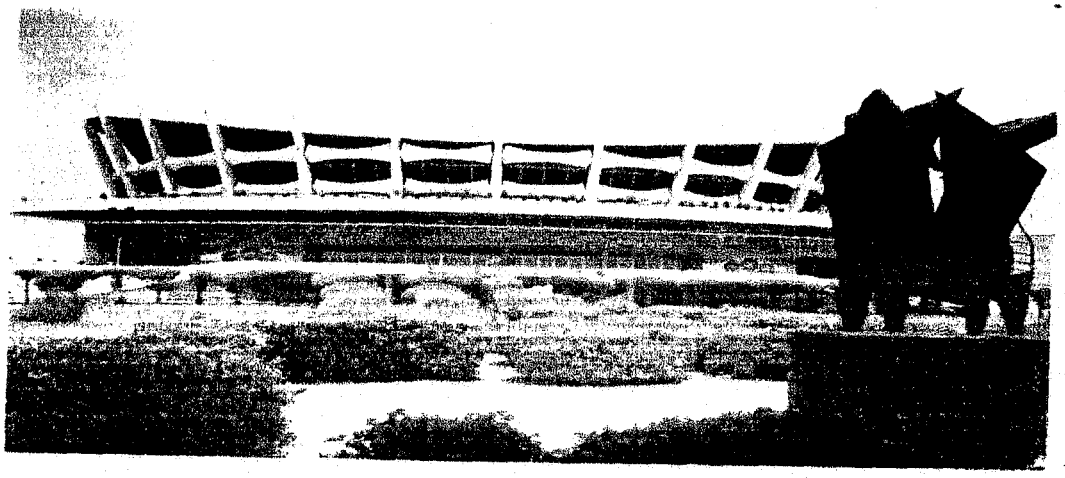
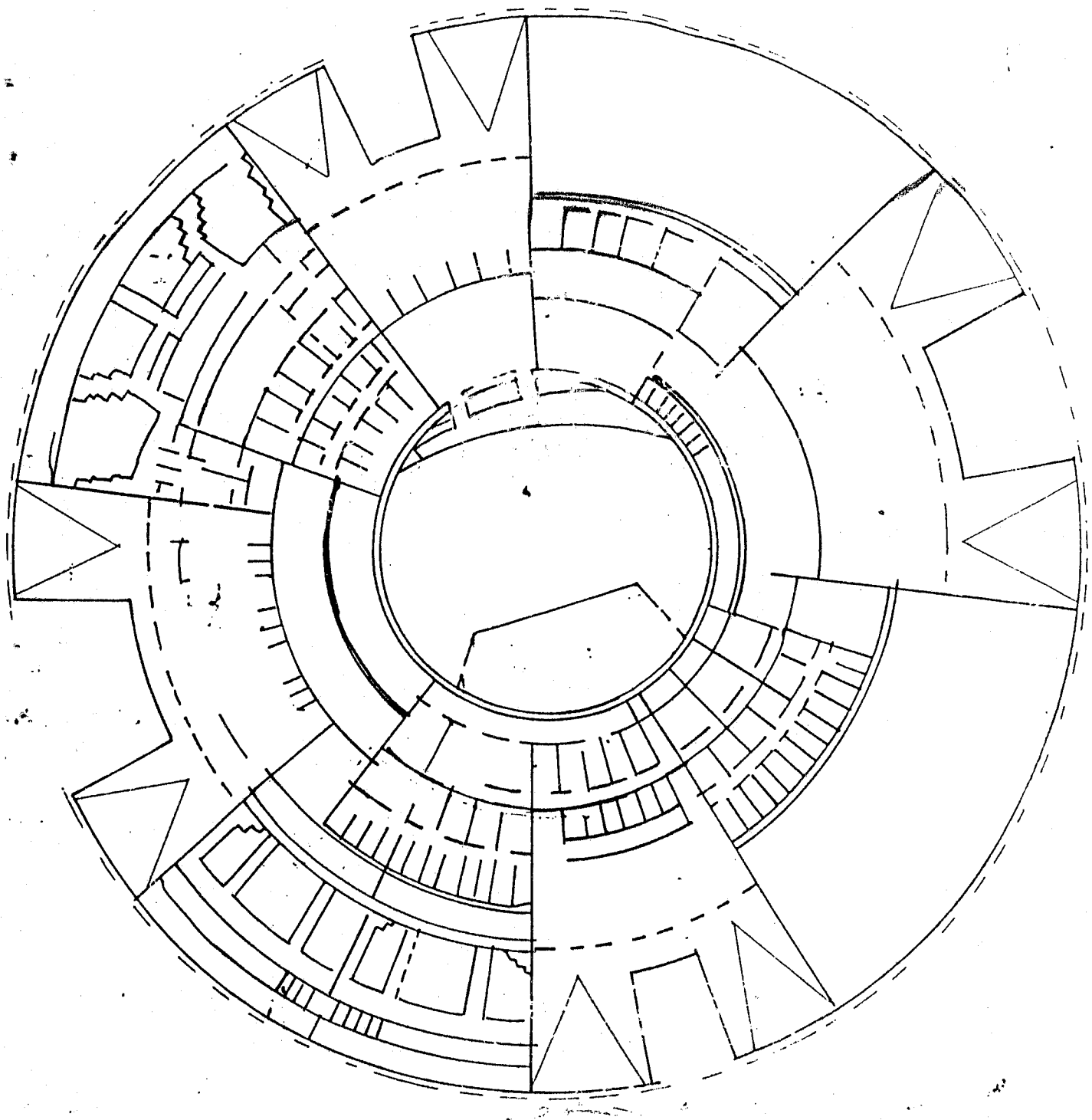


Plate 1a: front elevation of the national theatre

Plate 1b: side elevation of the national theatre.



- **Layout of the ground floor of the national theatre Iganmu, Lagos.**

4.2 CASE STUDY 2: U. K BELLO ARTS THEATRE, MINNA, NIGER STATE.

4.2.1 LOCATION

U.K Bello arts theatre is located along the U.K Bello road off IBB Road, off Paiko road in Minna Niger state.

4.2.2 HISTORY

U.K Bello arts theatre was designed and constructed by Julius Berger Nigeria Ltd. The theatre was commissioned on May 25th 1991 by the then military president, General Ibrahim Badamasi Babangida in honour of the late Colonel U.K Bello the then presidential bodyguard who took a bullet meant for the president in a coup attempt in 1990. Colonel U.K Bello died as a result of the bullet wounds.

4.2.3 FACILITIES PROVIDED

The following facilities are contained in the U.K Bello arts theatre

- shops
- an auditorium with a seating capacity of 550 people
- an amphitheatre
- exhibition spaces
- a museum
- a sit-out
- a restaurant.

4.2.4 MERITS

- Adequate space for the outdoors, and future expansion.

4.2.5 DEMERITS

- No provision for the disabled (ramps)
- Limited number of parking space
- The amphi-theatre is small, and is not raked
- No board or conference room for meetings

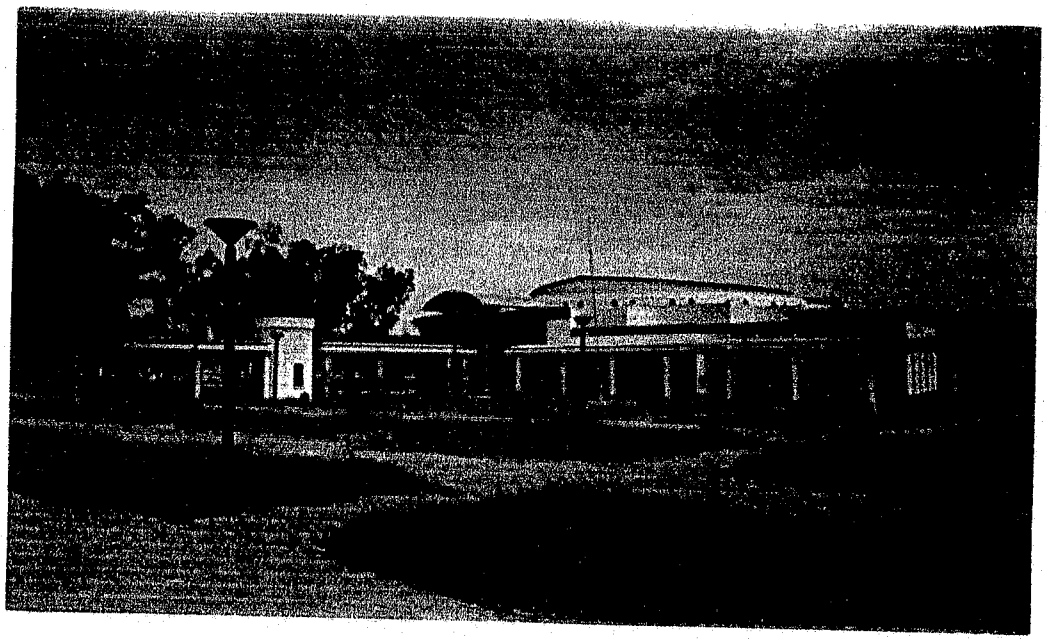
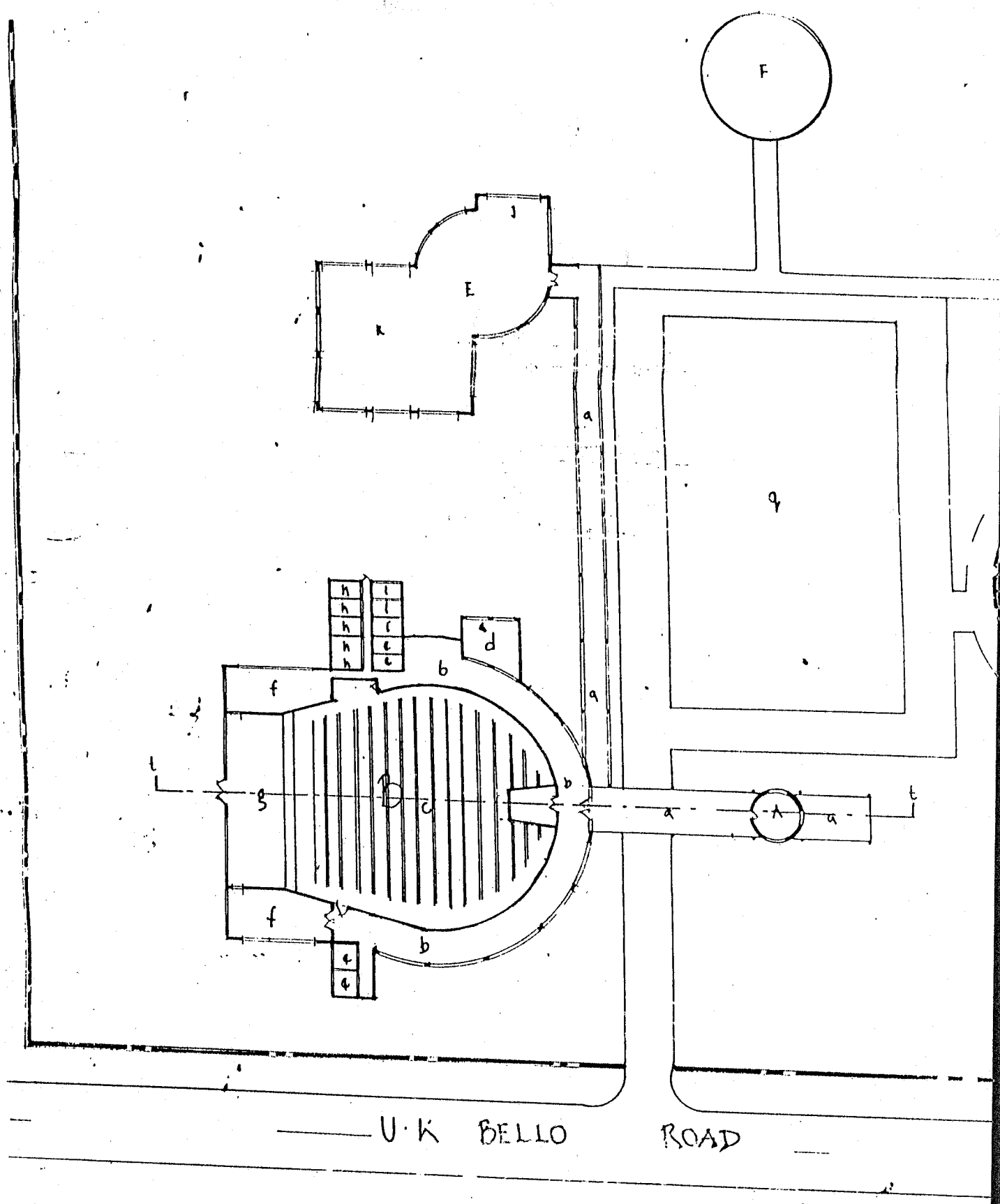


Plate 2a: view of the auditorium in the U.K Bello arts theatre

Plate 2b: view of the shops in the U.K Bello arts theatre.



Layout of the auditorium of the U.K Bello arts theatre, Minna, Niger state.

4.3 CASE STUDY 3: WOMENS CENTRE AUDITORIUM, CENTRAL AREA, ABUJA.

4.3.1 LOCATION

The women's centre is located along the road in the central area of Abuja. It is opposite the central Bank of Nigeria headquarters.

4.3.2 HISTORY

The women's centre was built in 1991 as a base for the "better life for rural women" organization which was founded by the then first lady Mrs. Maryam Babangida.

4.3.3 FACILITIES PROVIDED

The facilities contained in the women's centre auditorium are as follows

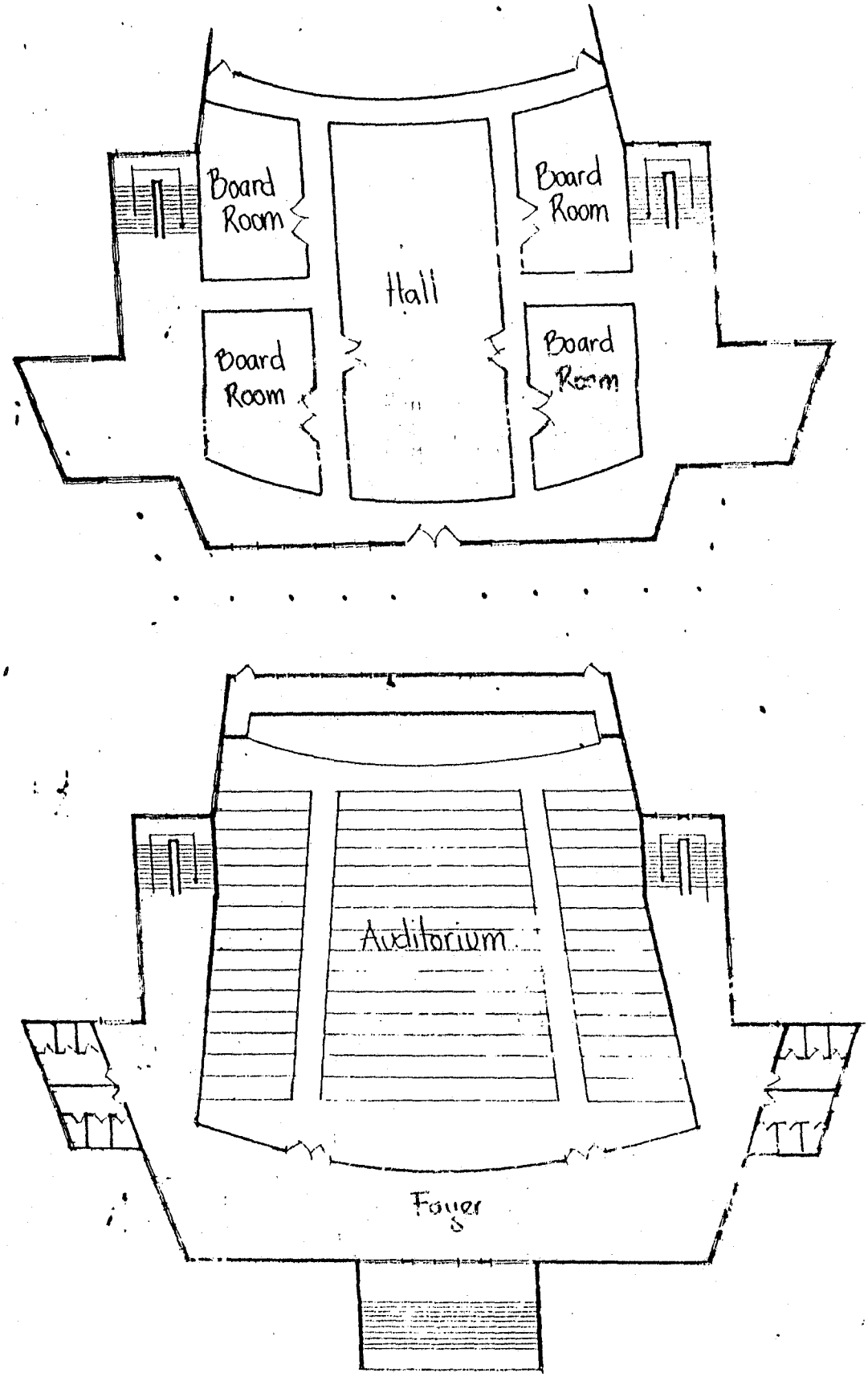
- an auditorium with a seating capacity of 1500 people
- four boardrooms
- exhibition space
- a hall

4.3.4 MERITS

- Board rooms and a lettable hall is available, and they have a separate entrance

4.3.5 DEMERITS

- No provision for the disabled (ramps)
- The auditorium shares a compound with other buildings
- The windows in the auditorium do not give enough light
- The back stage is not big
- No backstage facilities i.e. changing rooms.



Layout of the auditorium in the women's centre, Abuja

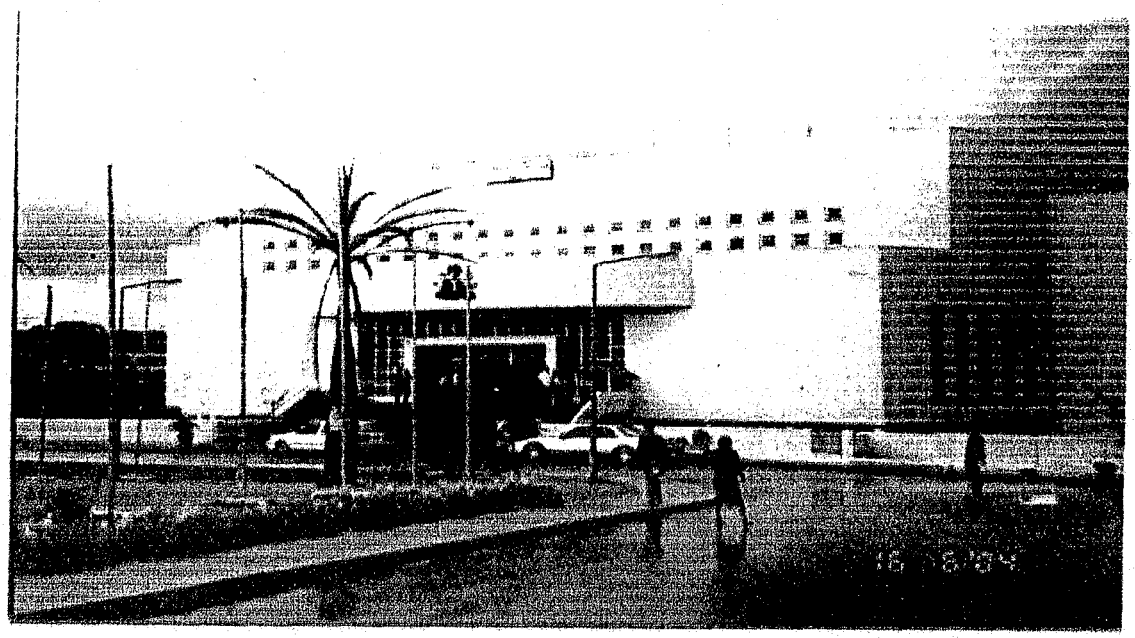


Plate 3a: front elevation of the auditorium in women's auditorium Abuja.

Plate 3b: basement view of the auditorium in the women's centre Abuja.

4.4 CASE STUDY 4: AUDITORIUM IN THE KADUNA TRADE FAIR COMPLEX.

4.4.1 LOCATION:

The Kaduna trade fair complex is located along Kaduna – Zaria expressway.

4.4.2 HISTORY:

The construction of the trade fair complex started in 1991 but was stopped due to lack of fund. It started again December 1996 to be used for the African international trade fair in April 1997. The former design made use of concrete and sandcrete blockwork. Due to time constraint, the latter design made use of aluminium cladding, membrane and insulated panels. About 20 contractors carried out the works.

4.4.3 FACILITIES PROVIDED:

The facilities provided include

- An auditorium
- Board rooms
- A bar
- Stage facilities.

4.4.4 MERITS:

- The theatre is very conducive for performing and viewing activities.

4.4.5 DEMERITS:

- The theatre is within a complex
- There is no changing room.

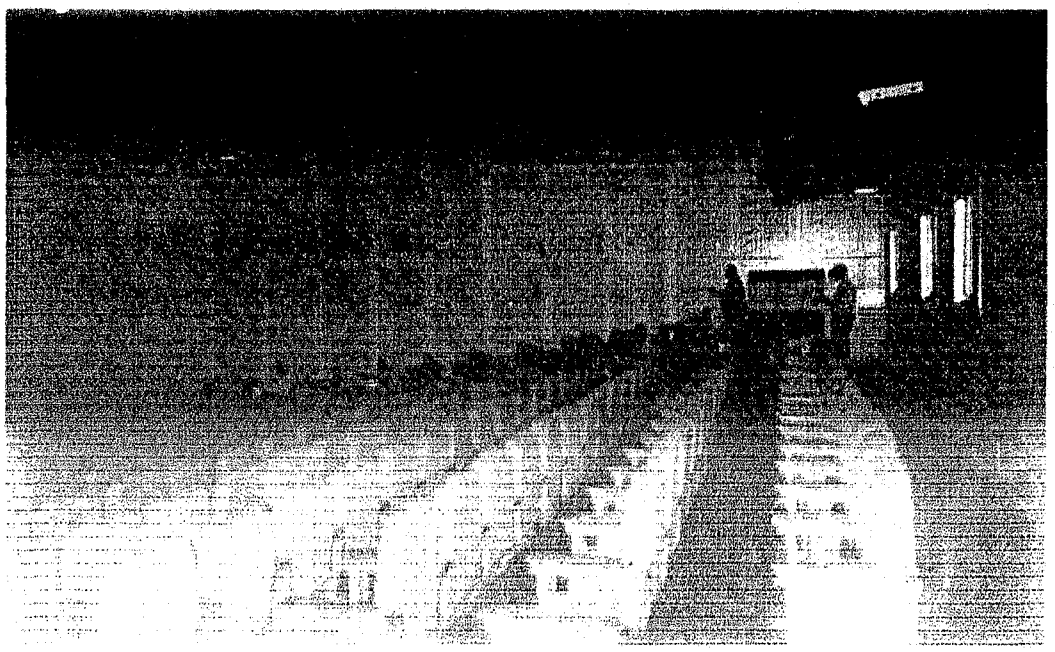
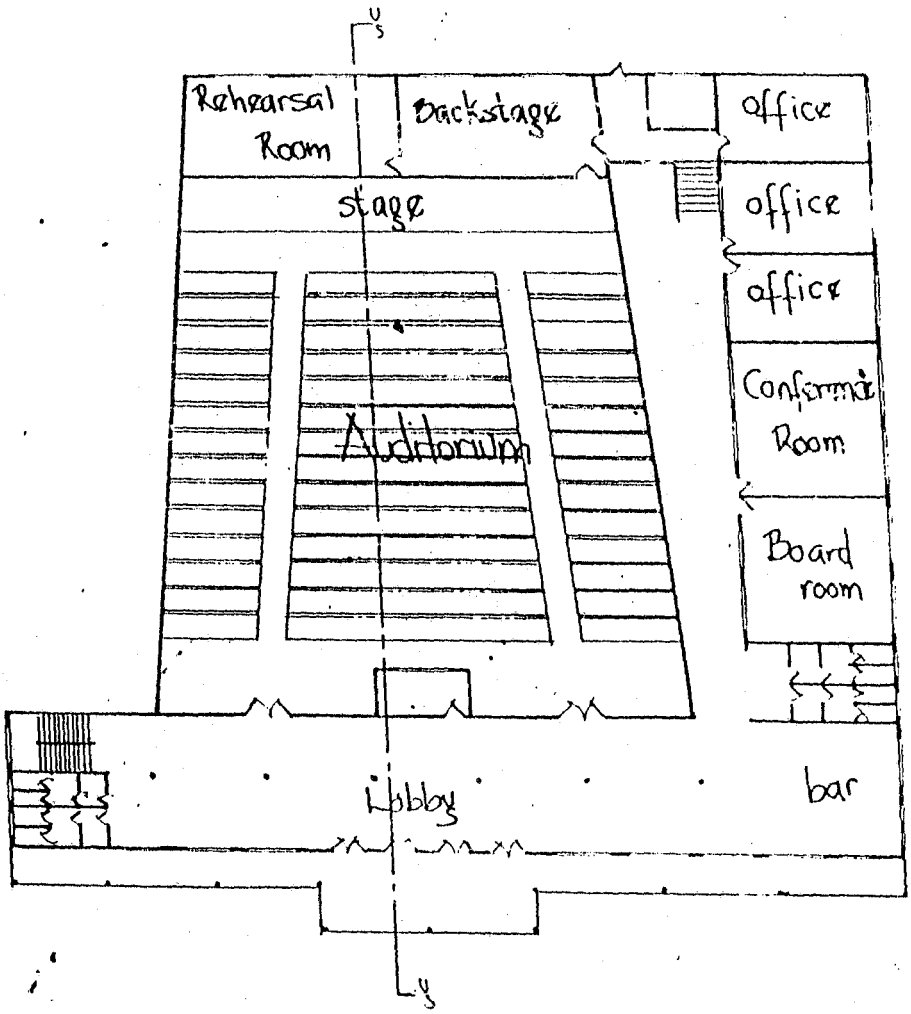


Plate 4a: front elevation of the auditorium in the trade fair complex, Kaduna.

Plate 4b: interior view of the auditorium in the trade fair complex, Kaduna.



- **Layout of the auditorium in the kaduna trade fair complex.**

CHAPTER 5 – DATA COLLECTION.

5.1 HISTORICAL BACKGROUND

The quest for a new capital city for the Federal Republic of Nigeria became worthy of official consideration by the then 11-day old government of General Murtala Ramat Mohammed, who like many other Nigerians observed that Lagos State, the then Federal Capital was associated with problems unbefitting a capital city. Such problems were:

a) Its peripheral location, which is bounded by the Atlantic Ocean, making it the nations number one entry port for international trade, and which meant that most Nigerians had to travel long distances to reach their capital.
b) Lagoons and creeks make land very scarce, resulting in the lack of space for future development, which should tally with the status as a capital of Nigeria.
c) Accessibility problems create infamous traffic problems, which lead to continuous loss of man-hours and mental distress.
d) Lagos state is associated with poor topography, inadequate housing, and environmental pollution.
e) The pressure of being both a state and a federal capital.
f) Lagos state being identified with one major ethnic group.

To examine and advice on this national predicament, the Federal Government, on August 9th 1975, announced a seven man committee carefully selected to reflect intellectual and individualistic competence. A renowned jurist, Dr Timothy Akintola Aguda, Dr Tai Solarin, Colonel Monsignor Pedro Martins, Professor O.K Ogan, Alhaji Mohammed Musa Isma, Dr Ajato Candonu, and Chief Owen Fiebai, headed the committee as members. The secretary of this distinguished committee was Chief E.E Nsefik.

Eleven days before the expiration of the deadline, the committee was ready with its report; it was the view of the committee that the problems of Lagos state would continue to defy solutions if it retained its multiple status of a state, federal administrative, commercial, and industrial capital.

In selecting a new capital, the committee anchored its criteria on thirteen factors. They are, in their order of priority: centrality (22%), health and climate (12%), land availability and use (10%), water supply (10%), multi-access possibilities (7%), existence of local building material (6%), low population density (6%), drainage (5%), soil (5%), physical planning convenience (4%), and ethnic accord (3%). It was also noted that for political reasons, the

Federal Capital Territory should be neutral ground, where Nigerians have equal rights and opportunities. As a result, on February 5th, 1976, a week before General Murtala Mohammed was assassinated in the streets of Lagos state, he issued a bold pronouncement that altered the course of Nigeria, both historically and geographically. The Federal Government decree number 6 of February 1979 established the Federal Capital Territory (FCT).

5.2GEOGRAPHICAL LOCATION :

On the map of the world, Abuja the federal capital territory lies between $8^{o}25'$ and 9^{o} 20' north of the equator, and longitude $6^{o}45'$ and $7^{o}39'$, east of the Greenwich meridian, which geographically places it at the centre of Nigeria. It lies above the hot and humid lowlands of the Niger-Benue trough but below the drier parts of the northern parts of the country. It was carved out of Niger, old Kwara, and Plateau states. Out of the 36 states that make up the federation, the FCT shares its boundary with four states: Kaduna to the north, Plateau to the southeast, Kogi to the southwest, and Niger to the west.

5.3 SHAPE AND SIZE :

The federal capital territory has the shape of the alphabet "U". It covers an area of about 8000 square kilometres (Niger provided 6328.4 square kilometres, Plateau 1313.4 square kilometres, and old Kwara 358.2 square kilometres.), which is more than twice the size of Lagos state. The federal capital city (FCC), Abuja is a crescent shaped city, placed in the north-eastern quadrant of the territory, in a position easily identified by aso rock. Abuja occupies 250 square kilometres, a mere 3% of the territory.

5.4 CLIMATE :

Abuja falls within the semi-dry sub-humid zone. The relief features that surround Abuja may slightly alter its climatic characteristics. The difference does not call for diverse architectural requirements, but for satisfying the micro climatic conditions, which may vary from one location to another.

5.4.1 RAINFALL:

Like other parts of Nigeria, Abuja is also affected by the dry and rainy seasons. Rainfall starts from March in the southern parts of the territory, and ends in November, while rainfall

starts from April in the northern parts of the territory, and ends around October. The duration of the rainy seasons vary: 240 days in the southern parts, to 290 days in the northern parts. Because of the location of the FCT, which is on the windward side of the Jos plateau, there is a general increase in the total amount of rainfall from the north to the south, rather than the usual decrease, which is characteristic of the entire country. Within the territory itself, northern locations have more rainfall than those in the south. For instance, Lokoja and Makurdi located south of the territory have 1146mm and 1132mm of total annual rainfall respectively, compared with Jos at 1402mm, and Abuja at 1632mm.

5.4.2 TEMPERATURE:

The FCT records its highest temperature during the dry season months, which are generally cloudless. During the dry season, the hottest month, which is March, could be as hot as 37° C. This period is characterized by high a diurnal range. Drops of about 17° C may be recorded between the highest and lowest temperatures in a day. During the rainy season, temperatures drop as a result of dense cloud cover. The diurnal range also drops to about 7° C especially July and August.

5.4.3 RELATIVE HUMIDITY:

Abuja records a relative humidity in the dry season of about 20% in the afternoon. Sometimes, about 30% is recorded in the extreme south of the territory, especially in the areas close to the Niger-Benue trough.

5.4.4 WIND:

There are two major air masses

a) **Tropical maritime air mass:** This is formed over the Atlantic Ocean to the south of the country. Warm and moist, it moves from the southwest direction, towards the northeast areas of the city. It creates the wet and rainy season.

b) **Continental air mass:** This develops over the Sahara desert. It is hot dusty and dry. It blows in the opposite direction of northwest to southwest. It creates the dry season also known as "harmattan."

5.4.5 VEGETATION:

The main vegetation of the FCT is guinea savannah, pockets of rain forest, wood savannah, park savannah, and shrub savannah. This reflects the true transitional nature of the area as between the southern forest and the northern grassland vegetation belts. As a result, almost all crops that can be grown in the southern forest belt and the northern grasslands can be grown in the FCT.

5.4.6 SOLAR DATA:

There is a general increase in the total number of hours of sunshine in Nigeria when you go further up north from the Atlantic Ocean. The sunshine hours range from about 5.1 hours in July to about 8.9 hours in November. October to February usually record the longest sunshine hours in the state.

5.4.7 GEOLOGY:

The soil in the FCT is predominantly reddish in colour. Sedimentary rock is located in streambeds and consists of sand, gravel, and local deposits of clay. The rock is of medium to high strengths, thus creating minimum engineering problems during construction. These rocks are normally quarried and used for construction work on sites. The igneous rocks include biotite granite, which comes in two forms: coarse rock and fine medium grained. It should be noted that no earthquake or landslide has been recorded in the federal capital territory.

5.4.8 LANDSCAPE AND TOPOGRAPHY:

The landscape of the FCT consists of tilted alluvial plains dissected by rivers Gurara and Usuma, a range of hills, inselbergs, and extension of the Jos plateau, popularly known as "jemma's platform" running through the middle of the territory. Topographically, the FCT has a gentle undulating terrain. Inselbergs and other granite clusters occupy about 80% of the total plain areas, and are generally rocky and occur as isolated masses or in groups of raising plains.

5.5 THE PEOPLE:

The federal capital city, Abuja is inhabited by people from across Nigeria. It is a city, the creation of which was achieved by people who longed for unity. Abuja is not owned by

one individual, group of persons, ethnic group, or state(s), but by all citizens of Nigeria, which led to its being called "no mans land".

The manifestation of various activities and the people who participate in them, point to the fact that it is a socio-cultural meeting point, devoid of one distinct custom or tradition. Apart from English, which is the official language of the country and Hausa, Igbo, and Yoruba, which are the main Nigerian languages, several other distinct dialects are spoken in various communities in the territory.

The role of the federal government in the development of the FCT has nipped in the bud the claims by any ethnic group of ownership of the territory. Nigerians have continued to express their sense of appreciation and acceptance of this unquestionable commitment of the government, by their influx into the FCT. This positive development is commendable, and Abuja cannot be said to be dominated by one or more ethnic group. The vision of Abuja becoming a symbol of our unity is almost realized.

5.6 ECONOMY AND COMMERCE:

In the FCT, returns on investment cannot be competed with by any other area or state in the country. This is especially true of investment in the in the housing sectors, where extremely high returns may be expected.

In the case of industrial development, the FCT has a number of advantages. First, it represents industrialization from a zero base, since there is little or no manufacturing as yet. This attracts prospective investors into the city. Secondly, the central location of the FCT will ensure that raw materials can be assembled from all parts of Nigeria, and finished products distributed at minimum cost.

These advantages are in addition to the mineral and agricultural resource base, as well as the size of the potential market. Mineral resources include marble, tin deposits, mica, lead, sand brick / ceramic clay, sand iron, wolframite, and tantalite. (Table 5a).

Ecologically, the FCT is a transition area between the grassland zone of the far north, and the forest zone of the south. Not only the current level of food crop production emphasizes the high agricultural potential of land in the FCT, but also the great variety of crops which can be sustained. Such crops include: tubers (yams and potatoes), legumes (groundnut and cowpea), grains (maize, sorghum, and rice), fruits, and vegetables. Animals such as sheep, cattle, and goats can be adequately reared.

5.7 TRANSPORT AND TRAFFIC FLOW:

In the FCT, there are two basic modes of transportation. They are:

a) Private transportation, which involves the use of personal vehicles,

b) Public transport system, where passengers pay a token fee to be transported to their destination.

In Abuja, there are three main types of public transportation:

-Taxis,

- Buses,

- Motorcycles popularly known as "okada".

The flow of traffic in the FCT is fast becoming congested, due to the large amount of influx of people into the city. However, the federal government is tackling this problem by increasing the width of the existing major roads, and creating new roads where necessary.

Mineral	Location	use
1) Marble	Buram, Ede, Kwali, Kusaki.	Building industry.
2) Mica	Kabin, Mangoro, Kusaki, Kwaita saba, Kwaita tsoho.	Wallpaper, filler in rubber, as coating for anti-rust.
3) Lead	Izom	Anti-rust
4) Sand, ceramic clay	Gwagwa, Kabo plains, Rubochi, Yaba, Bwari	Building construction
5) Wolframite	Gwagwalada, Rubochi.	Chemical industry
6) Tin	Kusak.	Anti-rust.

Table 5.1 minerals found in Abuja.

Sourced from the planning department: federal capital development authority, Abuja.

5.8 EXISTING LAND USE AND FUTURE TREND:

The master plan of Abuja provides for the development of the city in four phases: I, II, III, and IV. The phase I of Abuja comprise f five districts – Garki, Wuse, Maitama, Asokoro, and Central area. With the exception of the central area, the other four districts are mainly residential with health centres, secondary schools, markets, shopping centres, police and fire stations. The central area is the city centre. Phase II of the development is the Gwarimpa housing scheme which is currently being constructed.

CHAPTER 6: SITE ANALYSIS

6.1 SITE SELECTION CRITERIA:

The site selected is the plot of land set aside for the national theatre Abuja, in accordance with the Abuja master plan.

6.2 LOCATION OF SITE:

The site is located along the memorial drive off the Sani Abacha link way in the Wuse II district of Abuja. It is adjacent the Abuja Sheraton hotels and beside the CHOGM cultural village which is beside the Shehu Musa Yar'adua centre.

6.3 SITE CHARACTERISTICS:

a) **Topography, geology, and vegetation:**

The site is not flat. It has a steep slope in the centre, which slopes westward. The area is mainly underlain by granite and crystalline basement complex. Plains of sandstone characterize the soil. The ground is suitable for building adequate foundations, and is free of geological hazards. The vegetation is basically park savannah, surrounded by high trees and grasses.

b) **Climate (temperature, humidity, and rainfall):**

High temperatures occur in the dry season, where there is little cloud cover. The average daily maximum temperature ranges from about 29.5°C in July and August, to 34.8° C in March and April. The daily minimum temperature ranges from about 14.5°C in December and January, to about 25.2°C in May and June. The sunshine hours range from about 5.7 hours in July, to about 9.2 hours in November. October to February usually record the longest sunshine hours in the territory.

With humidity, it ranges from about 14 percent to 71 percent in the month of August. The total annual rainfall is approximately 1650mm. Most of it falls between June and September.

6.4 IMPLICATION:

In the design, the ability of the audience to have an uninterrupted view of the activities on the stage is mandatory. The best way to achieve that is to rake the seats which would require ground modeling or a site with a slope. In this case, the site has a slope which makes it very suitable for a theatre. For aesthetic reasons, the landscaping elements on site should contain trees

that would not lose its leaves during the dry season (deciduous trees). This will provide shade and reduce the wind speed. Other shading devices would be applied in tackling the problem of sunlight and glare.

As for rainfall, drainage systems capable of handling large volumes of water are required. Strong wind and intense rainfall could cause serious damage to roofs and skylights. That would also be taken into consideration.

6.5 ACCESS AND CIRCULATION:

The site of the proposed Abuja arts theatre can be accessed from three sides: from the Wuse market, through the Sani Abacha link way, from Zone 4 through the Sheraton road, and from the central area, through the Sani Abacha way. Circulation within the site is expected to be smoothly carried out with proper planning.

6.6 UTILITY:

The site contains the essential infrastructural services. Water supply to the site is from Lower Usuma dam, and is provided through trunk pipelines. The main source of electricity supply to the city and other parts of the territory is the Shiroro hydroelectric scheme through the National Electric Power Authority (NEPA).

The master plan of Abuja provides for a central sewage system. The main objective of the system is to ensure that wastewater is properly disposed of without polluting the water bodies and the environment.

6.7 EXISTING FEATURES:

Apart from the natural features i.e. the trees, grass and shrubs, the site is void of other objects.

6.8 GENERAL APPRAISAL OF THE SITE:

The location, topography, geology, vegetation, and climatic factors of the site make it suitable for the purpose of situating a theatre.

CHAPTER 7: DESIGN; BREIF, CONCEPT, PROPOSAL AND CONSTRUCTION.

7.1 DESIGN BREIF:

The main objective of architecture is to give man a dwelling. To dwell means to belong to a social system where mans physical counterparts are figurally defined in individually characterized settlements. It is only through interaction with existing structures of his settlements that man forms an overall image of his environment.

This research project puts forward a design proposal for an arts theatre. The site is located along the memorial drive in the Wuse II district. This proposal amongst other things is to provide a conducive venue for the viewing and the showcasing of performing arts which would meet international standards.

For an arts theatre to be successful, a combination of facilities provided is an important determinant factor. The necessary facilities include:

a) Administrative unit
b) Exhibition halls
c) An auditorium
d) Lettable halls

7.2 CONCEPT:

'The character or expression of any building can only be achieved if it is itself a total expression. Like any work of art, it must be dominated by a strong simply concept. All of its parts must be an active part of one dominant attitude. This is true whether the elements and decisions are big, early ones, like plans and structural systems, or latter ones, like interior colour and doorknobs. This challenge of making a building a total expression seems to m the highest and most difficult one. But it is the one I think must concern all of us most.'

- Eero Saarinen -

Eero Saarinen on his work.

'Symbolism ... must have cultural relevance. Architecture can have an esoteric level but it must also mean something to ordinary people. Symbols can make use of essentials of history, but they must be historically incorrect.'

- Robert Venturri –

'Imageability ... that quality in a physical object which gives it a high probability of evoking a strong image in any given observer'

- Kevin Lynch –
Image of a city.

'... Metaphors identify relationships between things. However, the relationships are abstract rather than literal. Similes are metaphors that use the word 'like' or 'as' to express a relationship. Metaphors and Similes identify possible patterns of parallel relationships.'

- Introduction to architecture -
Edited by James C. Snyder and
Anthony Catanese.

Concepts are ideas existing in human imagination, which forms the basis of the evolution of an object. Any visual image cannot be called a concept until it is portrayed in whatever form. It is also a means of expressing ones in-depth feelings of an abstract existence, in the form of a drawing.

7.2.1 SITE CONCEPT:

The motive here is to organize an effective means of locating and distributing facilities on site, producing a harmonious and organic flow of architectural entities, and taking proper advantage of the existing views, integrating them with the existing features on site. The most important factor to take into consideration when dealing with a site concept is circulation. If visitors' movement within the theatre is with ease, it would give them psychological and physical comfort. An effective site circulation pattern would be adopted as it would improve the circulation pattern and minimize the amount of energy wasted on futile walking around. The possibility of future expansion, services, traffic, drainage, deliveries, and adequate parking space would be taken into consideration.

After the above-mentioned factors are taken into consideration, zoning of the functions on site would be adopted. Site zoning simply means the grouping of similar functions or facilities serving the same or similar purpose. Zoning could also be grouped as a result of segregating noise from noisy areas, and less noisy areas, or defining the use of space as public or semi-public areas.

The site layout would be based on the zoning of noise into noisy areas and less noisy areas.

7.2.2 DESIGN CONCEPT:

The design approach for all the buildings in this proposal is based on the canonic design approach, where the form results from the organization of the functions of each unit.

7.3 DESIGN PROPOSAL:

a) **Administrative unit:** The administrative unit takes care of the day to day running of the theatre. And the booking of halls.

b) **Exhibition halls:** an arts theatre needs a hall for the exhibition of art works.

c) **Auditorium:** An auditorium is necessary for the suitable viewing and showcasing of performing arts.

d) **Lettable halls:** Lettable halls would be provided for the members of the public to rent for dances and ceremonies should the need arise.

7.4 SPACE ALLOCATION:

"The main aim of space allocation is to achieve the basic requirements of human comfort in such space. A number of important criteria must be considered to arrive at functional space allocation."[1]. They are as follows:

a) Anthropometrics
b) Required furnishings.
c) Intended use

a) Anthropometrics: "This is the study of basic human dimension in various postures i.e. sitting, standing, bending, etc. Various standards exist for the adult male and female, which should be considered in space allocation. An idea of the prospective users is required to make allowance for the differences in size".[2]

b) Required furniture:

Different rooms require different furniture. The required furnishings of a room affect the size of the room. For example, a classroom would contain more furniture than an office, and would therefore be larger.

c) Intended use:

"The intended use of any space is an important criterion for space allocation. If the use were similar, the level of sophistication would become the modifying factor. For example, the personnel manager and the managing director of a firm both require office space. However, the manager directors' office requires more sophistication for bureaucratic reasons and would therefore be made bigger." [3]

UNIT	AREA (square metres)
a) AUDITORIUM	
- Auditorium	1963.75
- Mezzanine floor	490.0
- Office (x 6)	96.0
- Shops (x 6)	96.0
- Ticket room (x 3)	24.0
- Lettable halls (x 4)	816.0
- Costume and changing rooms	180.0
- Workshop	180.0
- Rehearsal room	360.0
- Backstage	120.0
- Conveniences	60.0
- Lobby	390.0
- Carport	30.0
TOTAL	**4805.75**
b) EXHIBITION CENTRE	
- Exhibition hall	314.2
- Museum	254.5

- Hall of fame	132.7
- Offices	48.0
- Conveniences	36.0
TOTAL	**785.4**

7.5 CONTRUCTION MATERIALS:

The properties of construction materials vary in strength, stiffness, elasticity, resistance, density, and thermal conductivity. They usually come in standard shapes and sizes unless specified otherwise. The type of building materials used in construction should be carefully considered as it plays a vital role in the life span of a building. Construction materials are usually considered under three headings:

- Economic value
- Mechanical properties
- Aesthetic qualities

The area of research for this thesis is the use of glass as a building material. Therefore, glass would be predominantly used, either as a composite material, or as an aggregate. Steel sections would be used as reinforcement for the glass, and concrete would be used as a supporting material, mainly for the floors.

Steel refers to any of various iron-based alloys having carbon content less than that of cast iron and more than that of wrought iron. "Although classified as an incombustible material, steel loses its strength when subject to temperatures over 520`c. When used in buildings requiring fire resistant construction, structural steel should be coated, covered or enclosed with fire resistant material"[4]. Since it is normally subject to corrosion, steel should be painted, galvanized, or chemically treated for protection against oxidization. Steel is can be used for light and heavy structural framing and is usually used as reinforcement.

Concrete is an artificially engineered material made from a mixture Portland cement, sand, and gravel mixed in a ratio of 1:3:6 or 1:2:4 and a calculated amount of water (about 1~1.5 times the volume of cement) to give a paste, that when hardened binds

the entire mass. It is the most widely used construction material. Concrete is desirable as a building material because it can be moulded to virtually any form or shape. It can also be finished with various surface textures and colours. Concrete has the qualities of being strong, economical and durable. It is strong in compression but weak in tension. Using properly designed steel as reinforcement can increase the tensile strength of concrete. Under normal circumstances, concrete grows stronger as it grows older. Concrete is usually moulded into blocks or pre cast elements. Due to their lack of strength as a unit, concrete blocks are arranged in particular patterns to gain strength. They are arranged to form load bearing and non-load bearing walls. Mortar would be used as a binding agent where concrete blocks are used.

Mortar is a paste, which serves as a binding agent in masonry. It is also used in the plastering of walls. Mortar is a mix of cement, sand and water. The ratio of cement to sand is 1:3 and enough water is mixed in to give the paste the required consistency.

7.6 CONSTRUCTION:

The construction of a building is usually done in three stages.

a) Stage 1: The substructure, which is the foundation. Strip foundation would be used.

b) Stage 2: The superstructure, which comprises of the exterior and interior walls, door and window fittings.

- Insulated laminated glass would be used for the exterior walls,
- A combination of laminated glass, tempered glass, and glass blocks would be used for interior walls.
- Ground floors would be made of reinforced concrete, while all other floors would be made of laminated glass.
- The doors and windows would be made of insulated glass units.

c) Stage 3: The roof structure. A variety of roof structures would be used for various building;

- The auditorium would be roofed with a combination of cable net roofing, flat roof, and steel barrel vault roofing. The roof covering would be a combination of fibre glass and glass reinforced concrete.
- The exhibition centre would be roofed with a geodesic dome, and insulated laminated glass would be used as the covering.

d) Stage 4: Finishes and installation of and fittings.

- The walls of the auditorium would be finished with panels made of foam glass.
- The floor would be carpeted.
- The ceiling would be finished with perforated glass and polystyrene reinforced concrete panels.
- Stage 5: External works
- The walkways would be surfaced with large units of reinforced concrete slabs. All joints between paving slabs would be filled with mortar.

7.7 DEFINITION OF TERMS

MEZZANINE: the lowest balcony in a theatre

7.8 REFERENCES

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2. Ibid
3. Ibid
4. Francis D. K .C and Cassandra A. (1999). *"Building construction illustrated"* third edition. Mc grawhill press Ltd. Pp36.

CHAPTER EIGHT: DESIGN SERICES

8.0 DESIGN SERVICES:

Services within a building include the design, installation, distribution and maintenance of utilities in building. These utilities refer to the ventilation and distribution of air, plumbing, sewage disposal, fire safety, energy conservation, electricity and acoustics. As a general rule, designers should integrate the formal requirements of architecture and building services with a consistent and visually coherent structure. This principle needs to recognize that the life of some building services is shorter than that of the structure, by as much as a ratio of 3:1. This means that some or all of the building services in a building may be renewed or upgraded during the lifespan of the building. The cycle of changes and the different lifespan of individual parts of the building suggest that accessibility and renewability are key considerations in the design process.

8.1 ELECTRICITY AND LIGHTING:

The main supply of electrical power is provided by the National Electrical Power Authority (NEPA). The supply is stepped down from the 13KVA transmission lines by a step down transformer. An alternative source of power would be provided in the form of standby generator to supplement NEPA's power supply. The generator would be equipped with an inbuilt automatic starter which would activate it once there is interruption in the main supply system.The National Electric Power Authority (NEPA) would be well informed of the total estimated electricity load required during the planning stage, to confirm services available, and co-ordinate the location of the services required. Services can be connected in two ways:

a) **Overhead:** this type of connection is less expensive, accessible, and can carry high voltage over long areas. It however has a disadvantage of reducing the aesthetic value of an area.
b) **Underground:** this type of connection is more expensive and it guarantees protection of the cables during extreme weather conditions. It is used mainly in high density areas.

Electricity provides power for light, heat, and operations of appliances.

Outside the theatre, the planning of overhead lines should take into account the visual amenity value of the structures, which will ultimately be of greater importance for

the success of the theatre, than the additional cost incurred for its protection. Electricity poles should be integrated into the landscape. They should be constructed underground or diverted away from areas of high scenic attractions. External lighting is an important factor in creating interest, and a social atmosphere during evening shows.

8.2 HEATING, VENTILATION AND AIR CONDITIONING:

Generally, human comfort is of great importance in the design of any building. Ventilation forms a critical factor to be considered when designing. Ventilation is necessary to replenish oxygen, dilute the concentration of carbon dioxide and water vapour, and to minimize the concentration of unpleasant odours. A certain amount of air movement or ventilation takes place by air leakage through openings in walls, usually doors and windows. This capacity of ventilation might not be suitable for larger rooms, and rooms that would occupy a large amount of people. Cooling systems are therefore introduced.

The following factors are considered in the selection, design, and installation of heating and cooling systems:

- Performance and efficiency.
- Fuel and power services required.
- Type, size and location of equipment.
- Noise and vibration control.
- Outlets.

There are two main types of systems. They are:

a) **Central system:** This type of system allows for a more convenient location of the plant, more sophisticated control, and higher efficiencies. Central heating or cooling systems are more suitable for large and public areas.

b) **Unitary system**: This system makes provision for individual choice, as each room can have varying temperatures. This type of system is used in private areas, usually accommodation areas.

The design of a cooling system depends on the type of structure in which the system would be installed, the amount of space to be heated or cooled, the speculated amount of occupants in the room, and the nature of their activities. The location of these services depends on the size and proportion of the space, the area to heat or cool, and its

wall, ceiling and floor construction and finishes. The possible noise pollution should be taken into consideration.

8.3 WATER SUPPLY:

The main source of water supply is the Lower Usuma dam. The transmission from treatment plants is facilitated by gravity through trunk pipelines. An adequate and reliable supply of potable water should be provided for the theatre. Specific provision must be made for fire-fighting supplies, such as suitable pumping systems connected to hydrant points to meet fire authority standards. Water from rainfall would be drained by the site drainage system.

8.4 REFUSE DISPOSAL:

Refuse disposal is of utmost importance in any habitable environment. It is not dependent on any fixed system and can therefore be done in many ways. Refuse bins would be placed at strategic locations for the collection of refuse. This helps discourage people from littering the environment. The refuse should be disposed of constantly, as it encourages neatness, and eliminates possible air pollution. To simplify disposal, all smaller bins would be emptied into large communal containers which would be constantly emptied by the Abuja Environmental Protection Board (AEPB).

8.5 FIRE SAFETY:

Adequate measures should be taken in the preservation of human life and property. There are two main factors that lead to the outbreak of fire:

- Smoking habits within the proximity of combustible materials and heat appliances.
- Weather (lightning and earthquakes) or bad connection of electrical wiring.

Listed below are measures that should be taken against fire outbreak and spread within a building:

a) Materials of little resistance to fire spread would not be in the construction of the resort.
b) Smoking habits amongst visitors and members of staff should be discouraged.
c) Areas prone to fire outbreak should be regularly inspected by members of staff.

d) The use of fire detection devices such as smoke detectors and fire alarms should be encouraged, as it aids in alerting people and the fire stations of a fire outbreak.

e) Temporary fire fighting gadgets should be provided for use before the arrival of the fire brigade. Such gadgets include portable fire extinguishers, fire hydrants, and sprinklers.

8.6 DRAINAGE AND SEWAGE DISPOSAL:

The health implications of an improperly drained site are high. Effective prevention will be in the use of both drains and sewers. Drains are pipelines laid and maintained by the local authority under state owned roads. Sewers are a more elaborate system of drainage. The advantage and economic importance of a combined system is that the drain runs from each building and cuts the expense of individual connections.

The sewer scheme for Abuja is planned in such a way that sewage is collected from the neighborhood through tertiary sewer lines via secondary lines to interceptor sewer lines. The discharged sewage is collected to trunk sewer lines for conveyance by gravity to the central treatment plant for final treatment. Site drainage is achieved by the means of water sprouts and pipes, which would lead to main sewage lines.

Site drainage is necessary to prevent erosion and the collection of excess surface water or ground water resulting from new construction. There are two types of site drainage:

- Subsurface drainage: this consists of an underground network of piping for conveying ground water to a point of disposal. Excess ground water can reduce the load carrying capacity of the soil at the foundation level, and increase the hydrostatic pressure on a building foundation.
- Surface drainage: this refers to the grading and surfacing of a site in order to divert rain and other surface water into the natural drainage pattern.

8.7 SECURITY:

It is recommended that enough security officials be employed to oversee the theatre as valuable artifacts would be housed in the exhibition centre. Adequate telecommunication facilities should be provided to enable them co-ordinate and monitor

activities within and outside the building. External lighting should also be provided in the evenings as an aid to security and public safety.

8.8 ACOUSTICS:

There are three main areas to consider when taking into consideration the acoustics in a room. They are;

- The floor
- The walls
- The ceiling.

Acoustic ceilings provide integral acoustic treatment along with an adequate ceiling system, usually in the form of tiles on floor construction. This treatment should be implemented in the cinema and public hall to ensure adequate reception of the public address system. Double walling treatment and double glazing of the glass curtain walls is done to reduce noise to a minimum. Treatment would also be given to the doors. For the ceiling and the walls, foam glass would be used, while the floor would be carpeted.

8.9 MAINTENANCE:

To ensure a high level of maintenance, a maintenance agency should be employed to see to the day to day running of the theatre, the repair of work, and the renovation of objects that would need attention. The adopted pattern of the site is a mixture of both natural and artificial landscape, and is designed to minimize the cost of maintenance.

8.10 COMMUNICATION SERVICES:

- **Emergency, safety, security, and control systems:** Are essential to cover a wide range of requirements: protection (monitoring), alarm (fire, security, system failure), and specific action (switch to fire mode, emergency, supplies). Most systems are computer controlled. Safety provisions also include lightning conductors, electrical grounding, and overload protection.
- **Computerized management systems:** Cover administration requirements like: reservations, account billing, employee records and maintenance.

CONCLUSION

As the population of the FCT is growing, social amenities like hotels, clubs, shopping centres, resorts and so on are being provided. This has to a reasonable extent taken care of the active social needs of the population, but the passive social needs have not yet been adequately met. Even though all forms of government amenities relocated from Lagos, The National Theatre did not. This led to the almost non existent showcasing of dramas, concerts, plays and movies because of the lack of a venue suitable to house the population of Abuja. Presently, hotel conference rooms, and the auditoriums in the women's centre and the Nigerian Universities Commission are being used. The Nigerian Universities Commission auditorium can only be used weekdays, during working hours, and the use of the auditorium in the women's centre is more flexible, but lacks appropriate facilities. The lack of a suitable venue has resulted in a decline of the growth and spread of performing arts, and the high cost of tickets whenever an event is showcased. Sometimes, shows are presented two or more times during a day to accommodate the audience and still the venues are crowded, resulting in the need for a theatre in the federal capital territory.

In the past, when glass was mentioned in buildings, it was assumed that the glass was used for the doors and windows. But in recent times, glass can be used for any element of a building not compromising the strength and stability of the building. Due to its brittle nature, it is usually assumed that it is unsuitable for rooms were acoustic control is needed because it would reflect the sounds, I believe this research shows otherwise.

In the future the use of glass is surely to increase further, both for exterior and interior of buildings. Techniques and aesthetics which are ever more important are ever easier to achieve with new technology in glass production.

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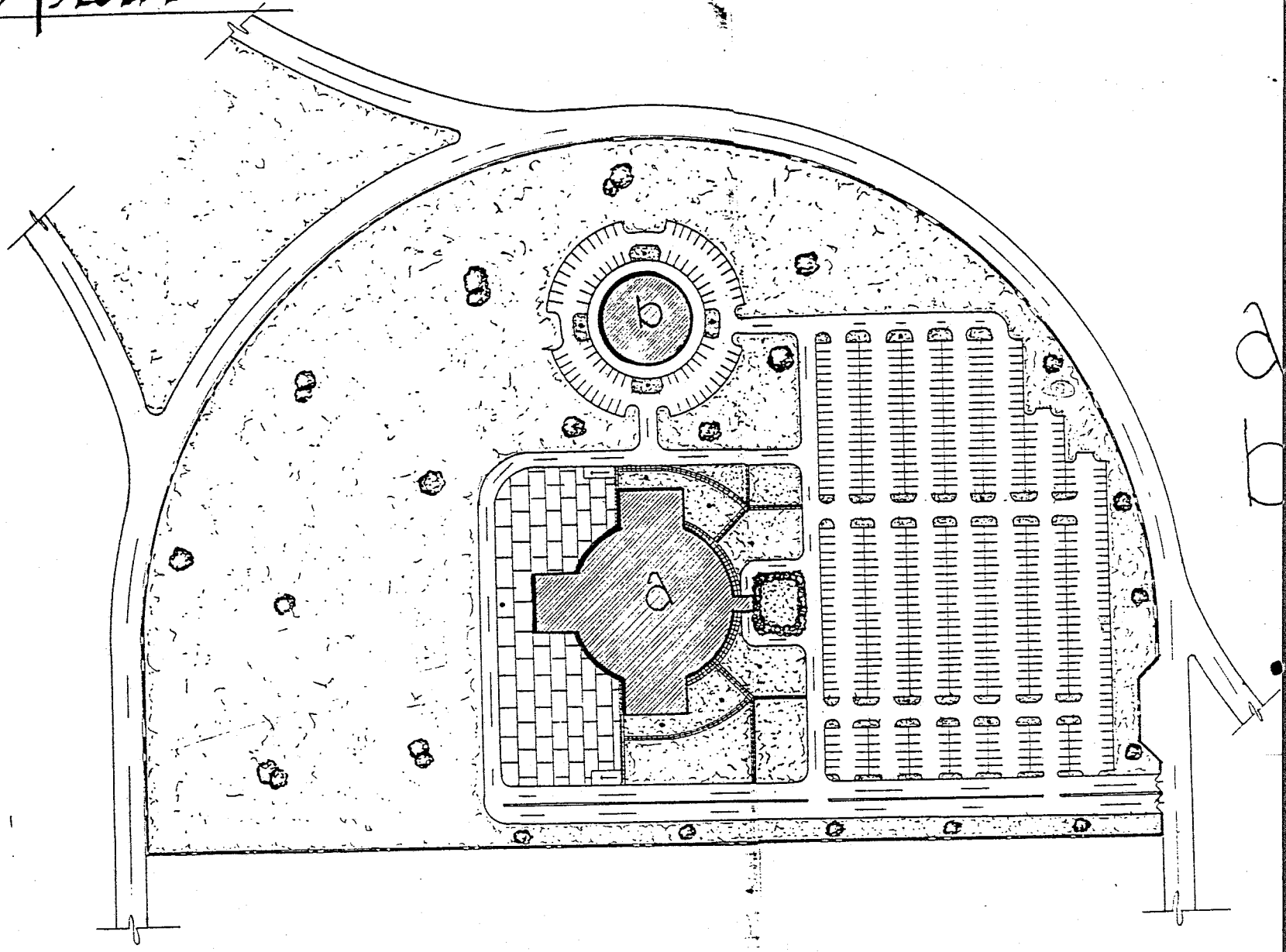
site plan



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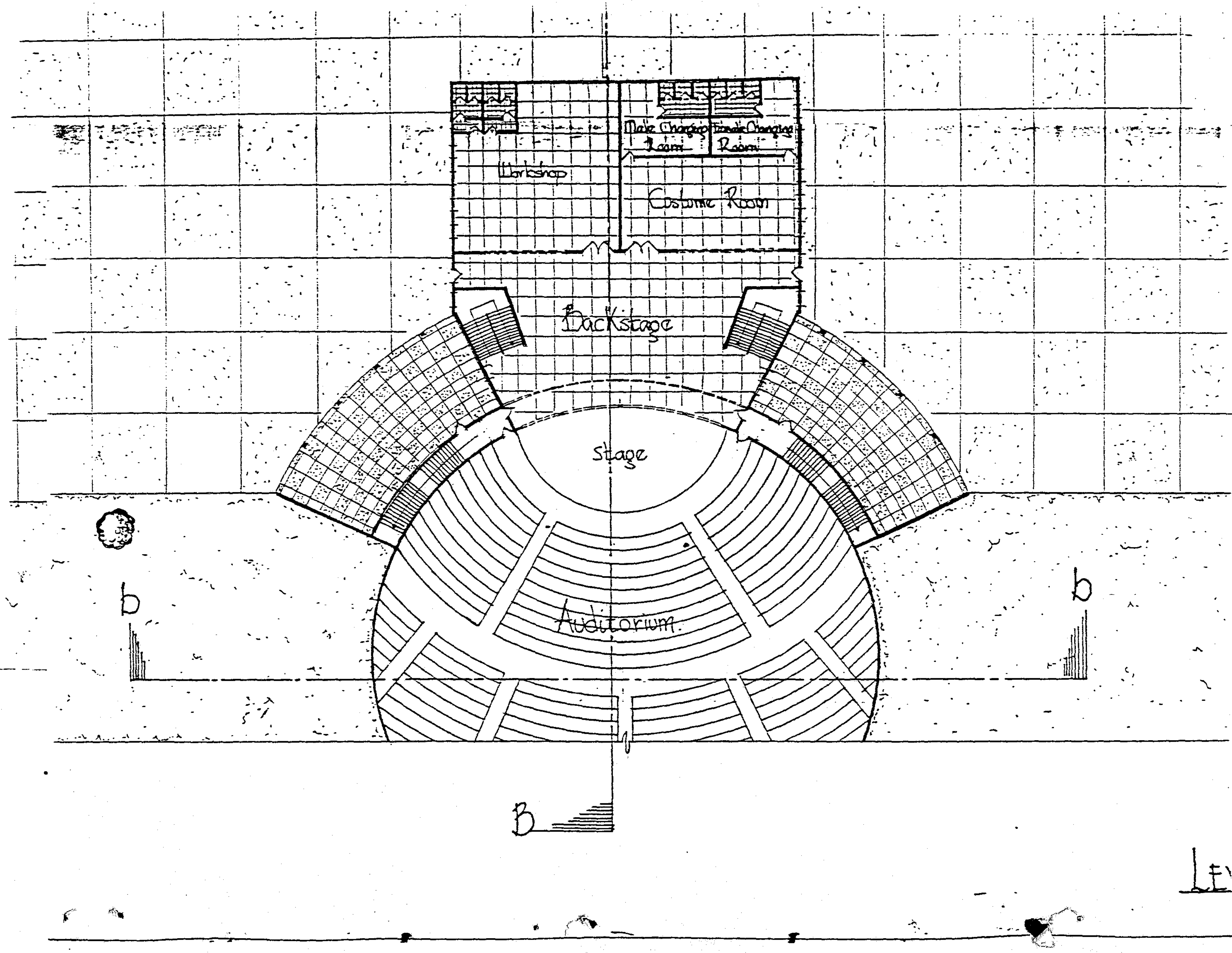

Male Changing Room
Female Changing Room
Workshop
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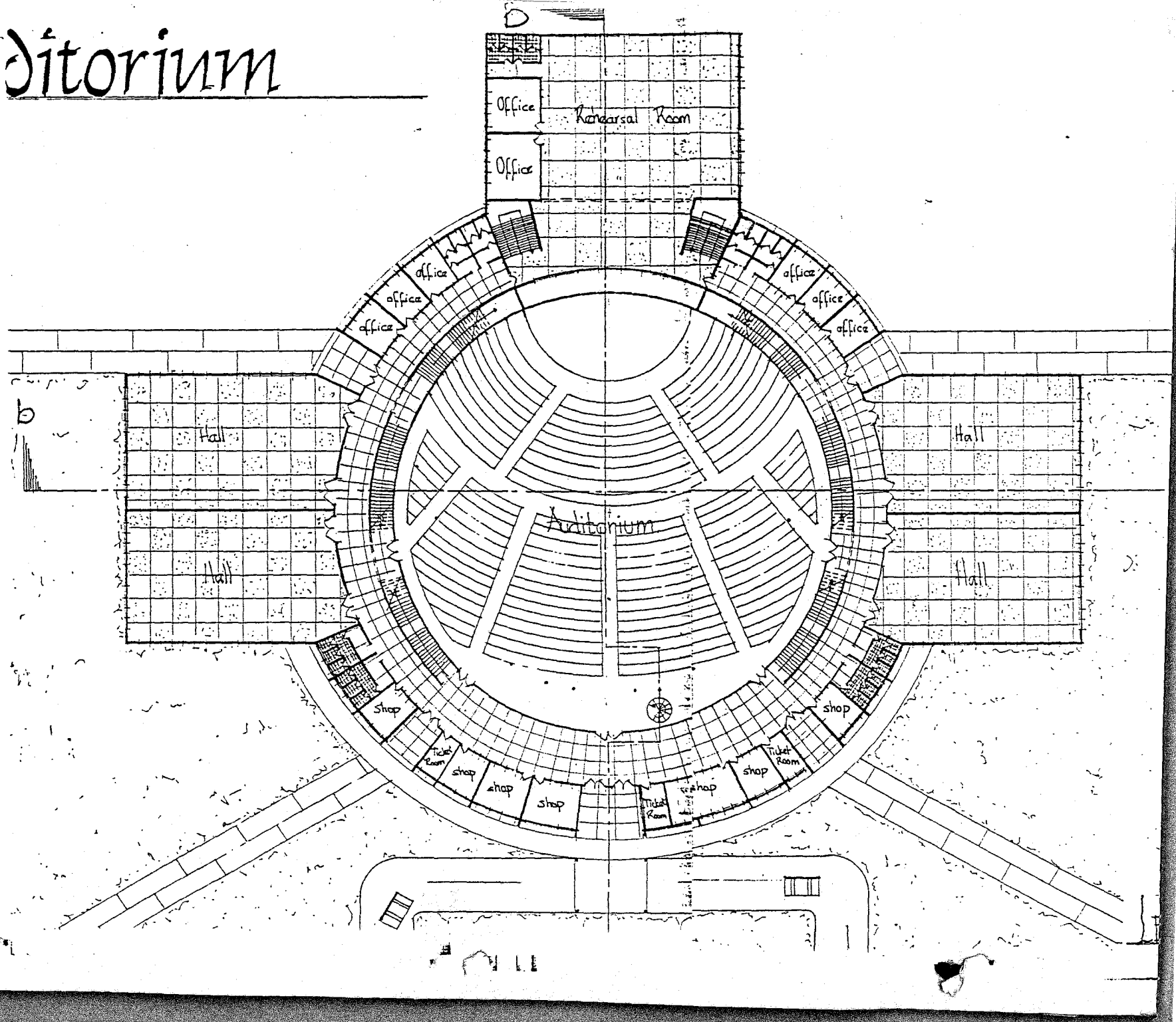
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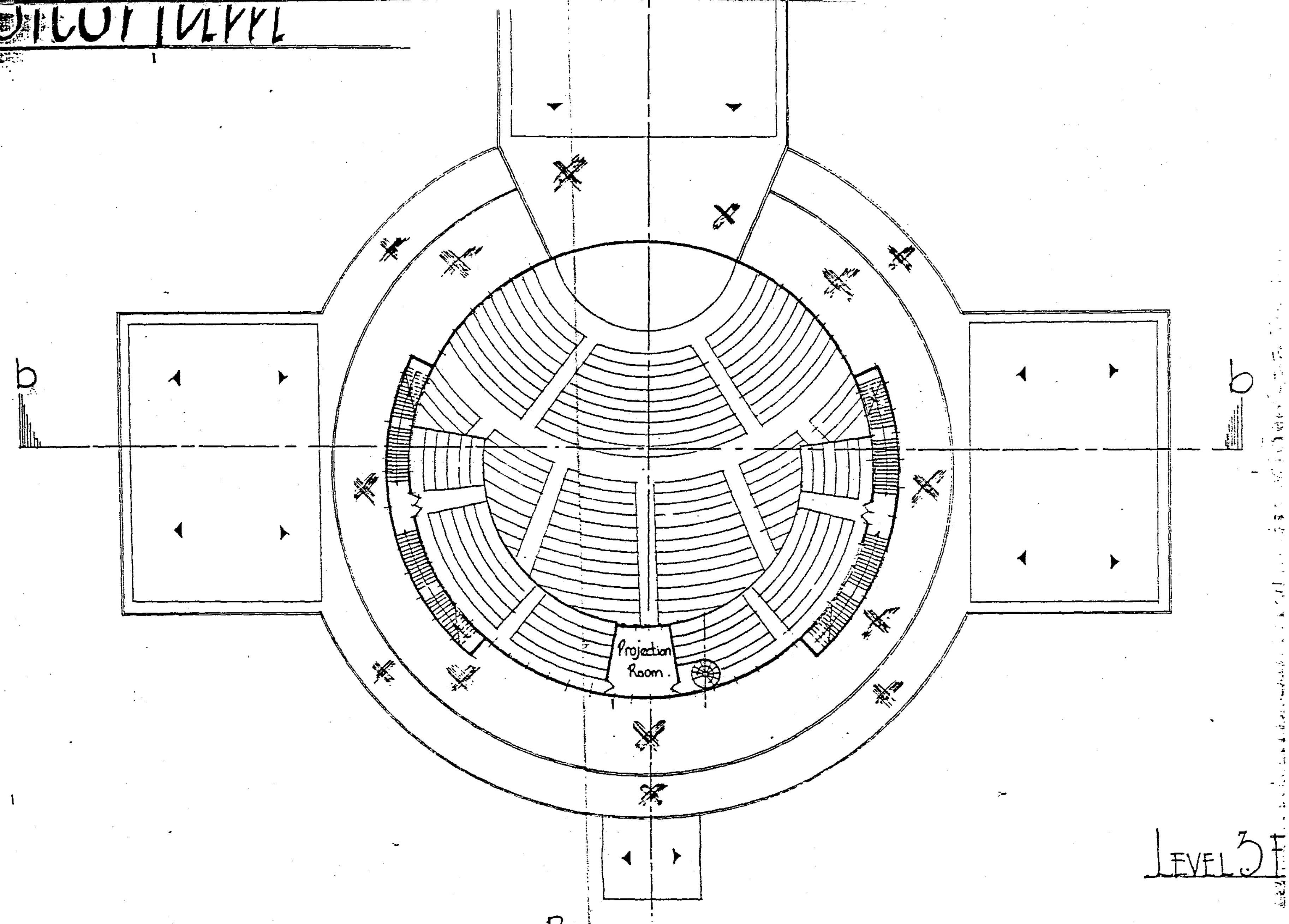

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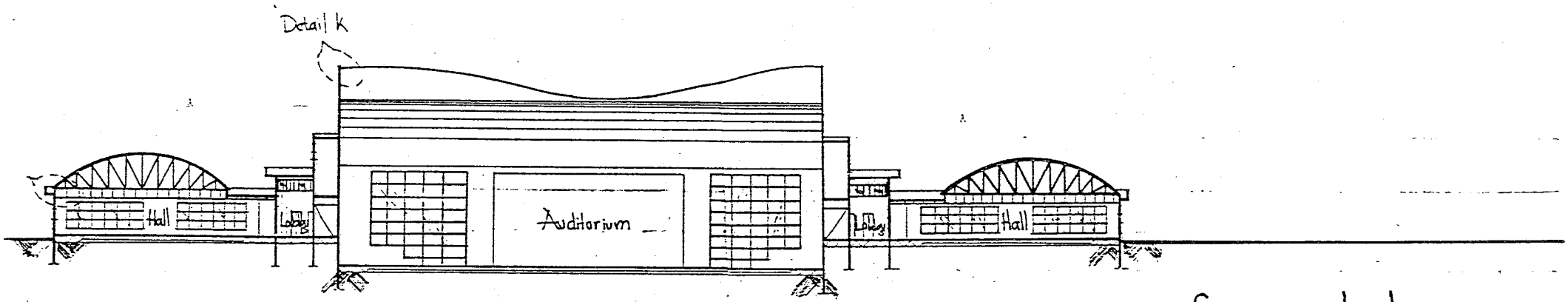
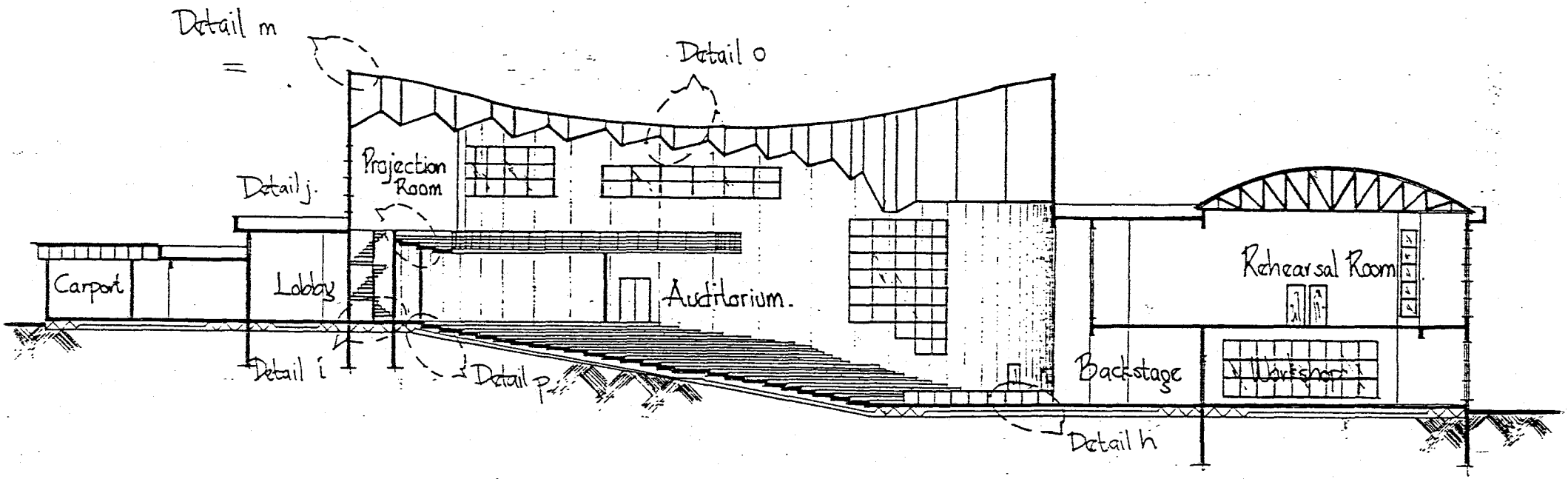
Design proposal for

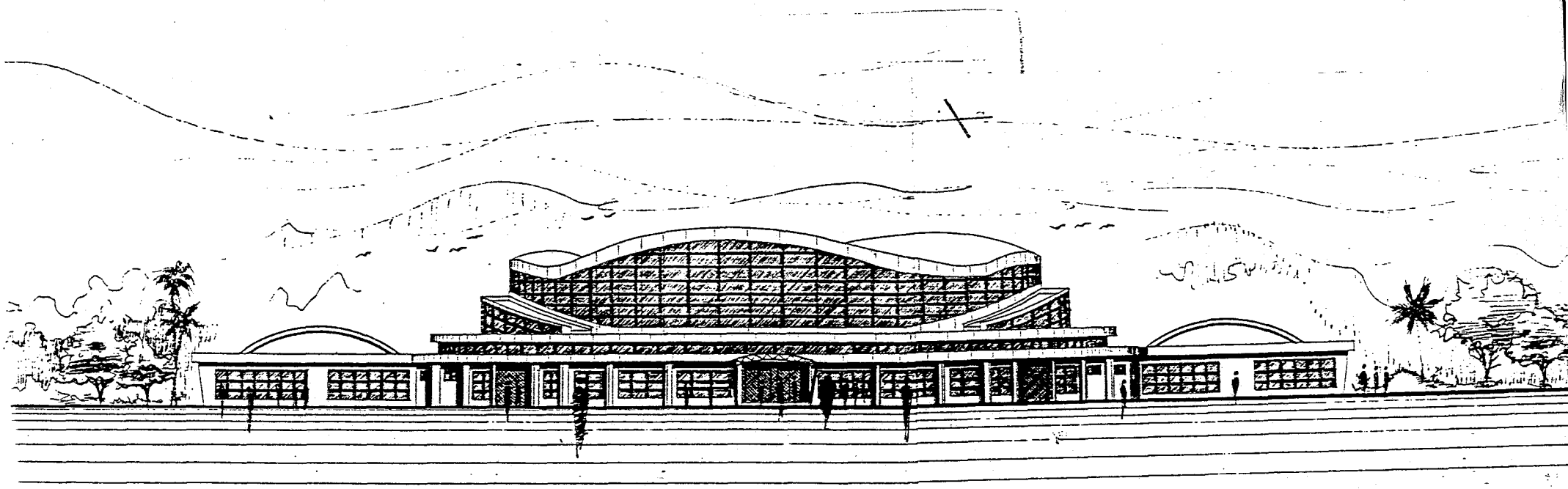
Abuja arts



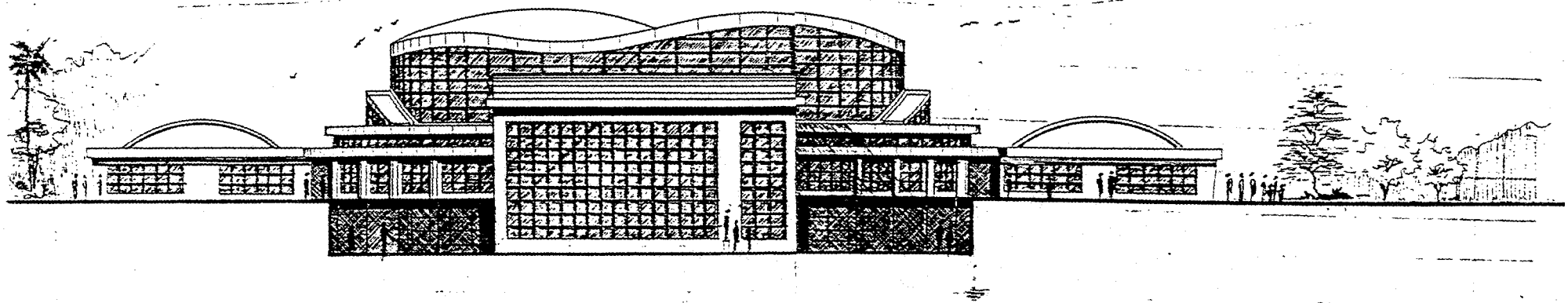
SECTION b-b


Detail m
Detail o
Projection Room
Detail j.
Carport
Lobby
Auditorium.
Rehearsal Room
Backstage
Workshop
Detail i
Detail p
Detail h

Section B-B



Approach Elevation.



Back Elevation.