ADAPTABLE UNITS FOR NIGERIAN ARMY (TRAINING CAMP)

BY

JUSTIN OKECHUKWU MAURICE EZEOKE (B.Scf. Hons) Arch.

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DEDICATION

This piece of work is dedicated to:

My parents - for all they have represented for me.

My brother Maurice

My sister Chizoba - for all that has happened to her and

to all budding poets for the ability they possess.

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My appreciation goes to my parents Mr. and Mrs. P.I. Ezeoke for giving me life and teaching me, even from a tender age, the need to struggle for my independence in life.

I must also express my deep and engulfing admiration and appreciation of my darling brother Capt. (Dr) Maurice Ezeoke who has always been, along with hope-inspiring, wonderful and with whom I made the topic of this work.

Mention, I feel, must be made of my other brothers and sisters who helped in no little way to keep my emotions steady during this tough period.

In line with these people, I would very much express my gratitude to Associate ProfessorChiodzik who helped me immensely in pushing ahead with my work. I also extend my appreciation to all the staff members of the Department of Architecture, Ahmadu Bello University Zaria who helped me in this academic venture.

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THE MILITARY AND ARCHITECTURE

The military institution is one of the oldest institutions in the world though in varying shades.From the primitive man to the present-day computerised military services.

The military has had a tradition of regimentation with an unwavering regard for power structure or command structure.

The very essence of the existence of the military does not provide for complexity in any form rather, it makes for fundamentalism. Thus lack of complexity so totally pervaded the military set up that in contemporary architecture, what exists as military architecture could be classed as; (a) The "flow diagram architecture" or (b) "Architecture of hierarchy" and (b) Architecture of perpendicularity and (c) Architecture of solidity.

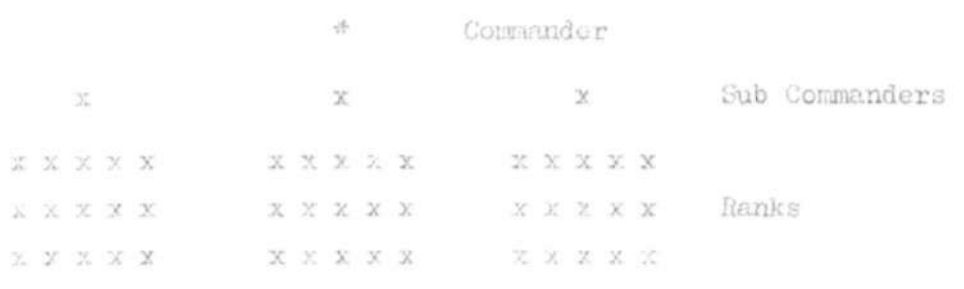
The flow diagram architecture

Flow diagrams are used to indicate movement in a design or amenities distribution in a design etc. The military aspect of architecture which falls into this group is that of the command structure, battle formations, form-ups for movement and in the communication system.

These aspects expose the intimidation of ranks in the Military where the highest in whatever parameter of measure, takes the command.

In military parades, the highest ranking personnel takes the front-most place, then the sub commanders and then the ranks (see sketch).

In battle formations, the commander takes the lead.



PARADE GROUND ARCHITECTURE

In this "flow diagram architecture" or "Hierarchy architecture" the lowly, submussively look up to the leader.

ARCHITECTURE OF PERPENDICULARITY

Surprise is the greatest element of a successfully executed battle. Being charged with the defence of a Country, the military had to devise a means of achieving surprise - Fast movement, with other attendant disciplinary requirements like silence.

In the Roman Empire, from where it is assumed this idea is been borrowed, they designed their barracks with perpendicular roads (CARDO and DECUMANUS) to enable the soldiers move the least distance to "Form-Up-Place". This was in the belief that the perpendicular distance to any point is the least distance to such a point.

All armies have adopted the idea of perpendicularity. that the first military training a recruit gets is how to stand perpendicular

to the ground - AT ATTENTION.

In the lay out of military institutions, perpendicularity is so unwaveringly observed.

Infact a soldier is brought up to be very straight in his dealings.

ARCHITECTURE OF SOLIDITY

Much as the military does not encourage complexities, it very strongly pursues solidity in most things that belongs to it. Solidity in this sense implies; strength, resistance to fast tear and wear etc.

This is why military arsenals inspite of age can perform any time they are remembered. It at the sametime explains why even military textiles are tough.

NIGERIAN ARMY

BRIEF HISTORY

The Nigerian Army evolved from the early colonial para-military units established to strengthen Britain's sovereignty and protect her economic interest in colonial Nigeria.

The earliest of these units was the Lagos constabulary founded in December 1863. Others were the Royal Niger Company Constabulary and the Nigerian Coast Protectorate Force.

In 1889, Lord Lugard formed an insipient body of what in 1900 became the West African Frontier Force (WAFF). The new unit expanded by absorbing the Royal Niger company constabulary and all para-military

units in the other British West African dependencies to fully become the W.A.F.F.

The first original Nigeria Regiment which comprised troops from Niger Coast protectorate force and the Royal Niger Company Constabulary was born following the 1914 amalgamation of the North and South of Nigeria.

The combined West African Command was disbanded in 1956 and the Nigerian arm, of this command, which was then known as the "Royal Nigerian Army" went on to be called, on assumption of a Republican status, "The Nigerian Army".

OBJECTIVES OF THE NIGERIAN ARMY

Section 197 of the Constitution of Nigeria stated among others, that the Federation shall, subject to any act of the National Assembly made in that behalf, establish, equip and maintain an Army for the purpose of:

(a) *Defending Nigeria from external aggressions*

(b) *Maintaining its territorial integrity and securing its borders from violation on land.*

(c) *Suppressing insurrection and acting in aid of civil authorities to restore order when called upon to do so by the president.*

(d) *Performing such other functions as may be prescribed by an act of the National Assembly.*

PREAMBLE

The primary essence of maintaining an army, (armed force) no matter the size, is to defend the integrity of the sponsoring country on land, in the sea and from the air.

The confidence reposed on any army and the financial involvements of the government sum up high that all efforts must be made by army involved to justify these huge investment on it.

Such justification can be assessed only in the ability of the army to perform in battle which does not come up that easily and that fast. Battles however, do come.

It will smack of irresponsibility for an army to wait for an attack before trying to get set to counter. Much as the Nigerian Army cannot in the least be classed as unprepared, this thesis aims at aiding the Army to be very completely prepared. This preparedness of the Army comes in various shades and forms.

For an army to be totally able to stand to the test of any invasion of the territory for which it is that army's responsibility to defend, that army must be very much accustomed to the terrains which abound in that territory. The reasoning behind this is not far-fetched: if a soldier is not trained to bear the obvious hardships which reign in very heavily forested terrains, for example, the morale of that soldier wanes fast immediately he gets the pinch of such fearful situations for which he has not been prepared.

Nigeria is very much blessed with various terrains and this project aims at siting camps in selected areas within these classed terrains to enable the army train to men in the terrains.

These camps in military parlance could simply be referred to as INFANTRY WARFARE TRAINING CAMPS

OR

REAR BASE FOR INFANTRY OPERATIONS.

USE OF SOME MILITARY INSTITUTIONS

BARRACKS:

This is basically a set-up that affords military personnels with accomodation.

DEPOT:

This is a set-up which offers different types of military training amongst which is the orientation of recruits into military life.

MY PROJECT:

This is aimed at offering a set-up where people stay and from which they set-out to experience our terrain types by conducting infantry manoeuvres in them.

WARNING!

On no account should any information contained in this book be turned over to the press.

CHAPTER 1

PROBLEM SYNOPSIS

Moving around and across Nigeria exposes to a keen observer, a variegated territory. I have ever been such an observer.

From the military point of view the Nigerian territory can be a costly asset to a forward-marching army. Nigerian army is such but, as I observed, has not been adequately and impressively utilising this territorial blessing.

Nigeria has five strategic terrain types which if properly married and mastered will produce a very sharp and ever-ready army.

Going through any book on the 2nd world war campaigns in the Far East Asia particularly in Burma areas, and also from some experiences, narrated by Gen Moshe Dayan, on his participation as an observer in Vietnam, in one of his books, one outright sees the overimportance of the knowledge of a terrain type for military exercises. The book by Gen Alex Madiebo on the Nigerian Civil war struck home the big need to get the soldiers to have a feel of all the available terrains in this country no matter the hardship entailed thereby.

This need is what I actually realised and thus want to contribute in improving the eventual battle-readiness of our army.

- WHY KNOW THE TERRAIN

"I kept abreast of military development, read public and private reports and received informations from a variety of sources on advances

in weapons technology and tactics. But first-hand experience added a dimension to understanding which second-hand description could never provide ....."

"The best, and only, military "laboratory" at the time was Vietnam". So I agreed to write newspaper articles and was accredited as a war correspondent. When he heard about it, as I discovered later, United States Defence Secretary Robert McNamara ..... to open all doors ..... So in early August 1966 I found myself in an American helicopter flying from Danang to the rear headquarters of 1st Air Cavalry Division. From there I was flown forward to join a jungle patrol. "We circled the camp before landing. ..... And beyond that, closing in from all directions, the jungle, a thick, dark-green mass of vegetation unlike any terrain I had ever fought over".

"American warfare in Vietnam was primarily helicopter warfare. There were altogether 1700 helicopters in the country when I was there - more than all the helicopters in Europe ..... It was the American answer to the problem of movement in the Jungle .... "

"Ninety out of every one hundred battles in the Vietnam war began on Vietcong initiative, when they deemed the circumstance favourable ..... "

"..... They (The Vietcongs,) were expert at moving through the Jungle, and when they wished to avoid combat, they split their units into small groups of not more than fifteen men and each took a different path to reach the new rendezvous.

"..... that the air cavalry (helicopters) was the perfect, though expensive, answer to the problem of mobility in the Jungle. There was no place they could not reach. But there was one thing they seemed unable to do - land their units quietly, secretly, without detection. The helicopters announced themselves every inch of the way and advertised every landing in the Jungle. The Vietcong, on the land, might take three months to walk from the north but neither en route nor before their engagements did they give themselves away."

The above excerpt from Gen Moshe Dayan's book on his life, indicates the obvious advantage of knowing the terrain well.

CHAPTER 2

AIMS AND OBJECTIVES OF THESIS

Primarily the inspiration to take on this thesis topic came from the observation I made regarding the utilisation of the terrain types in the country for military training purposes. This, like has been aforementioned, is to help in the battle-readiness of our ARMY.

The Nigerian Army however, has a biting accomodation problem which has forced the authorities in different locations to delve into affairs like acquisition of civilian houses and hotel accomodation for personnels.

These mode of housing have their attendant problems which can simply be summed up as, mocking the discipline that is the army.

It is thus in view of this that I developed as supplementan intention to my project which is accomodating where possible, personnels who otherwise will be lodged in hotels etc, in my camp.

This is intended to; save cost, curtail the unfortunately wrong notion of plenty which anyone in a hotel develops in due course of getting such an accomodation, bring beneficiaries of hotel accomodation, once more within military claws thereby inculcating discipline in those it is already slackening in.

CASE-STUDY

Such a camp as I have studied is intermittently set up in the plateau areas of Jos. It is the only one that has a constant site with some immovable infrastructures always ready for re-use.

PROBLEMS

This case study has a lot of architectural, human and military problems.

ARCHITECTURAL PROBLEMS:

Much as the layout is in a flat land and obeys the military notion of perpendicularity, the placement of some amenities (see sketch) disregarded architecture.

The general toilet which is removed totally from the "residential" area of the trainees and fronts the cooking area which is just an open area.

The water tank is placed poorly left open and is supplied or filled up by lorries and from it very leaky pipes which are exposed on the surface radiate out to some areas of the camp resulting, most times, in lack of water.

HUMAN PROBLEM:

In the architectural problem mention was made of the unfortunate nearness of the toilet and the kitchen.

The areas where the trainee live is away from this toilet and bathroom facilities which are in themselves not adequate in number with regards to the number of people who use them.

These living quarters are made of tarpaulin tents which are pitched over bare ground with no sleeping amenities at all. The prerogative to provide sleeping materials then rests on the trainees.

Unfortunately the only choice is military ground sheet as matress

and kitbag or packs for pillow.

It could be argued that soldiers should be tough and thus deserve such hard life. This arguement however, holds little water since I feel a soldier is toughened in such a situation as in the bush - during exercises - and outside the bush during exercises too.

Since these quarters are ment for the nights only, they should be more comfortable than they are now if man must be saved from total reduction to an animal.

MILITARY PROBLEM:

In as much as the tactical operations are carried out in peace time in the face of everybody, military institution of such tactical reach should always be away from the civilian flow of life for numerous reason one being to avoid civilian/military friction.

The case-study is almost surrounded by an industrial estate, some hotels and part of the town.

This is unfortunate and shouldn't be. It can almost correctly be said that very little regard was given to the military implication of this camp. The general briefing for battle maneuvres is done in the open. This could possibly be so as it is in a no-war condition but climatic situations alone can make the briefing a near-to impossibility. The sand models are exposed and can easily be disfigured by rain or wind.



PLATE NO 1 : RESIDENCE OF TRAINEES.
AT THE BACKGROUND IS AN INDUSTRY.



P.3. Q.M. ITEMS IN THE OPEN.

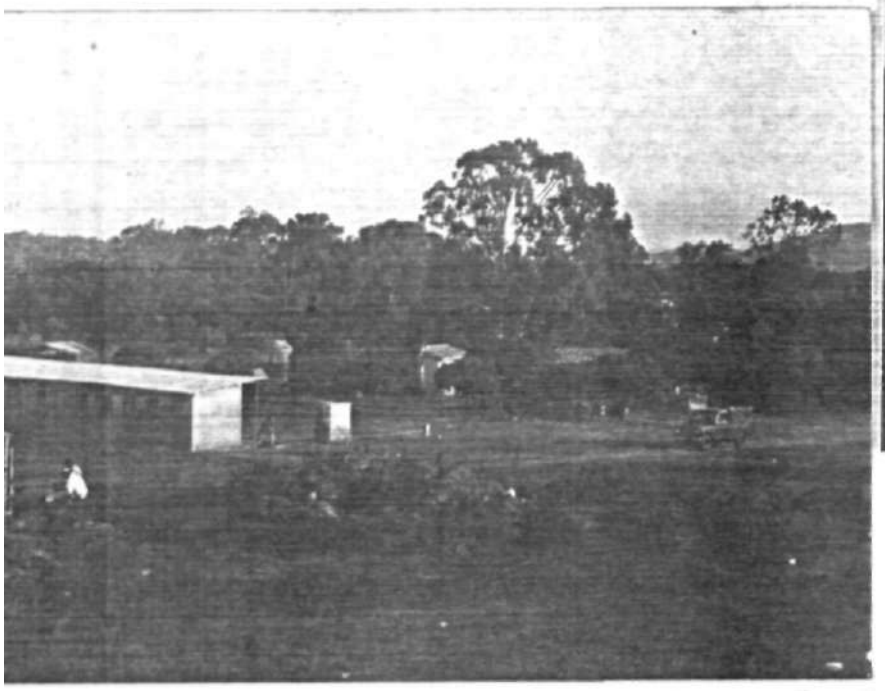


PLATE NO 2: THE TOILET FACILITY IN CLOSE LINK WITH THE WATER TANK AND THE OPEN-AIR KITCHEN.







MOSLEMS PRAYER AREA



AN EXPERIENCE IN SAVANNAH GRASSLAND MANOEUVRES.



MEDICAL UNIT



ONE OF THE MILITARY VEHICLES.

AMENITIES IN THE CASE-STUDY

Like in every military institution or set-up, the case-study has the following amenities which will be discussed separately: Administration unit, class-room units, mess-unit, accomodation units, security unit, medical unit, Signal unit, form-up place, motor-transport unit, quarter master unit and religion units.

All the amenities that require utilisation by all camp users are provided in two for trainers and trainees.

ADMINISTRATIVE UNIT: This is the centre for organising the camp. Unfortunately, there is no marked out area for such an important function instead the commandant uses the officers-mess to brief officers and the trainees mess for their briefing.

CLASSROOM UNITS: These units are supposed to serve for imparting the theoretical aspect of tactics and combat in general, to trainees. This lacks in clear-cut terms but improvisions like tree shades are made.

MESS UNIT This unit simply embraces all acturties of feeding and relaxation. In the case of the camp in question, two separate narrow blocks serve for this purpose. These blocks are architecturally inadequate by way of size, comfort to users and amenities like toilets.

ACCOMODATION UNITS: These units are two-typed: for trainers (officers) and for trainees and trainers (other ranks).

The accomodation units for officers are narrow single self-contained room (approx. 2.5m x 2.5m for the bedroom area).

The accomodation units for the other ranks and trainees are less fortunate. They are of tarpaulin tents (approx. 4m x 6m) pitched

over bare earth with a far-off toilet facilities. No matter the situation, such accomodation unit should no long be in use.

SECURITY UNIT: This in the common perlance is the guard-room. Made of terpaulin tents too, this unit is not very necessary but to achieve some intimidation, which is the military's main-stay, even if by its mere presence, it is constantly around in military set-ups.

MEDICAL UNIT: This has the function of caring for the medical welfare (very limitedly) of the camp users. There is no elaboration in its architecture as it is just of one very small tent which has three beds, for those on short-term emergency admission. Some medical services are provided from the ambulance.

SIGNAL UNIT: This is the communication life-wire of the camp. It gives communication links to major military set-ups outside the camp location. This like others is of tent.

FORM-UP-PLACE: This is simply the assembly area from where all activities start. Normally an open area to which many activities within the camp are linked.

MOTOR-EMBARKATION UNIT: Also an open area which serves as vehicular assembly for military vehicles.

QUARTERMASTER UNIT: This unit caters for the storage and distribution of supplies to the camp.

In the case study, due to inadequate storing facilites, many items are left in the open.

RELIGION UNITY: Military respect for religious inclination is almost to a fault. Areas are provided for religous worship. Thus is most possible for the moslems who, can make use of open areas for their prayers.

CHAPTER 3

NIGERIA

GEOGRAPHIC, CLIMATIC AND REGIONAL SETTING

Relief, topography and geology

The national relief varies from zero to 4,000 ft above sea level.

The primary geological structure of the country is made up of tertiary recent volcanoes, pre-cambrian basement, lower cretaceous, upper cretaceous, tertiary and recent rocks.

Inspite of the diversity, the areas, in many river valleys, which are susceptible to flood, provide plentiful sands and gravel.

CLIMATE, RAINFALL, WIND

Harmattan winds: (a) dry, cold and often strong (b) weather is dry, generally cloudless and day temps are high in the afternoon and low at night and early morning. (c) lazy atmosphere and plenty dust. (d) Brings discomfort to human beings and should be avoided in design.

S.W. monsoon

(a) warm and moist (across ocean)

(b) cloudy atmosphere

(c) rain bearing

(d) highly desirable for colling effects in design.

Temp:

Nigeria lies near equator so mean temp are high compared to that in most regions like in the temp climate. Temp varies greatly between the south and the northern parts of the country. Mean maximum temp

increase from coast northwards. The highest monthly mean of 90°F in the coastal region and 105°F in the extreme north. The mean minimum temp decrease northward with 70°F as lowest on the coast and 55°F in the north.

RELATIVE HUMIDITY

This varies with temp. In the extreme north, towards the end of the dry season, relative humidity may fall to 10% in the afternoon and 30% at dawn. That for the coastal region does not change as much as the northern region. There is generally high relative humidity in the wet season.

GEOGRAPHY

Although Nigeria lies wholly in the tropics, it has a hot climate, the sandy country in the north is dry while the low-lying swampy coastal areas in the south are damp and enervating. The rainy season extends from April to October in the north with rainfall ranging between 25" to 60"; the rainy season in the south is between March and November with rainfall between 60" (150cm) and 160" (400cm). The annual average temp is 80°F (27°C). There are four main geographical areas (1) an almost impenetrable swamp and mangrove forest area in the south (2) an Inland tropical forest ranging between 50 and 100 miles in depth (3) an area of open woodland and grass savannah beyond the tropical forest of about 100 miles and (4) a northern area of open land with an elevation of 2000 ft.

The most prominent physical feature of the country is the River

Niger with its main tributary the Benue. There is a great difference between high and low water - sometimes as much as 35ft (10m) makes navigation of these rivers impossible.

CHAPTER 4

EXECUTIONAL PATTERN

Nigeria's territorial expanse covers a land mass pushing up from the Atlantic ocean to her northern borders with the Niger Republic, thereby covering five distincts geographical vegetation zones namely:

- the mangrove swamp
- the fresh water swamp
- the guinea savannah
- the sudan savannah
- the sahel savannah

For my design purposes, I shall break the country in two major design zones:

- HOT ARID CLIMATIC ZONE
- HOT HUMID CLIMATIC ZONE

The zoning or break-up is based on the two broadest climatic occurrence in the country.

For my military intention, I am adopting the vegetation types.

THE ZONES

- Hot humid zone:

This area covers from Port Harcourt in the south to Makurdi at the southern bank of river Benue.

It is supposed, due to its area-span, to provide the Army with terrain types suitable for the following warfare training types:

- Jungle warfare
- Marine warfare
- Savannah Grassland warfare.

- Hot arid Zone:

This zone spans from the northern bank of the river Benue to the northern borders.

It is viewed as capable of providing the following training types due to its land cover:

- savannah grassland warfare
- mountain warfare
- open desert-land warfare.

THE NON-EXISTENT SITE

The project has military bias and so, is going to use sites that already belong to the military or lands that can be leased to the military from six years up to ten years.

The following conditions should be thoroughly met, unless otherwise stated, by any area on which my project will be sited.

(A) SIZE AND CONFIGURATION

The area should be large enough to provide for the activities of about three hundred men - minor military activities, games, relaxation etc.

A square land will be better preferred to straight or contorted land. A flat site is preferred but in its absence, a rolling site with

a gradient of 5% to 7% is acceptable.

(B) ACCESSIBILITY

In military regulations, accessibility to any location is a requisite for siting such a location. Since my project has a military bias it has to be well accessible to the municipal roads.

(C) WATER SUPPLIES

The need for very adequate water supply system in an area can not be overemphasized. The site should be in an area to which water supplies can easily be linked to, if it is non existent yet.

(D) GROUND AND SOIL TYPE

Different soil types have different and characteristics. Some shale soil for instance, has the aptitude to swell when water soaks into them.

The ground for the site should be visibly hard and should most preferably be the sandy loam or loamy soil type as these are particularly good for constructional purpose. Apart of shale and marshy land, any other soil type could be managed.

(E) DRAINAGE

A poorly drained area tends to make the soil there - no matter the soil type - to be water-logged and consequently marshy since I require hard ground for my sites, they should be well-drained.

(F) LOCATION

The site should be in an area already owned by the army or is very near to a military location. It should be very well removed

from civilian activities.

SITING THE PROJECT

Taking cognisance of the mobile nature of some units, transfer of personnel to different units, the training opportunities that the different geographical terrains of the country can afford and different military meets like range classification meet, top-flight meet etc, I have decided to divide the country into five military training zones this being the adoption of the vegetations of Nigeria.

In each of these zones, one of my units will be constructed.

I have chosen the Port Harcourt site for the purpose of reality thereby solving real, not imaginary problems. Other locations are Sokoto, Jos, Calabar and Ilorin.

CHAPTER 5

DATA COLLECTION

PROBLEMS

Conceding the fact that the country is classed as a developing country, one who is involved in an experimental research or any academic research requiring data that cannot be gleaned from the shelves of a library, is bound to face some hectic time collecting the proper data. I had a good share of this problem.

The project site is in Port Harcourt and the nature of the environment makes it imperative for any good-intentioned master-builder using the area for a project, to acquaint himself thoroughly with:

(a) The climatic condition of the area viz: humidity, precipitation, etc.

(b) Wind situation viz: direction, speed, period etc.

(c) Soil situation viz: soil types, behaviour, geological

(d) Vegetation cover and types.

(e) Insolation

With these in mind, I got to the town of Port Harcout and after frustrating calls at six different ministries, I was directed to the town University of technology from where an appointment was made with a time space of three months.

The appointment turned out to be friutless as the director of the institute with whom the appointment was made, confessed that they were still setting up their laboratories and were in due need of such data

as I was demanding. Eventually a stroke of luck brought in sight, the Shell-Development Ltd from where some encouraging information was collected.

From the military, access to the informations required by me was not much of a problem.

MILITARY LITERATURE

Military literature in respect of architecture is an aspect of literature that the literary minds have so wantonly abandoned.

In the era of the Roman-empire (of which enough chronicle is available), the history was bedevilled with military conquest and efforts directed towards achieving speed of movement and assembly of soldiers - Cardo and Decumanus barracks. This emphasized perpendicularity.

This, apart of the history of defence walls and moats around feudal boroughs, is the only history on military architecture that I was able to collect after exhaustive searches in different libraries, along with some traditional defence types in Africa.

These however, have little or no impressive bearing on contemporary military situations since now, achievement of speed of movement cannot be relegated only to perpendicularity of roads. Infact, if anything,, perpendicularity of roads could be a hinderance and a tell-tale of locations. It has thus been very difficult to come across any military literature which will provide reference or act as a guide to write-up.

PORT HARCOURT

HISTORY

This town, in which my site is situated, is and has always been a Nigerian sea port as it has a natural harbour.

Situated at the Southern tip of the country, in the coastal mangrove swamp forest belt, it has a lot of history to its record.

Once a very large ecumenical Roman Catholic province, Port Harcourt was a town under the defunct Eastern Region of Nigeria.

The government of the region in an enviable plan awarded a contract for a well planned and beautifully executed New town for Port Harcourt. This town became known as the Rainbow town and can still lay claim to being amongst the best planned towns in the country. With its tree-lined streets and beautiful house gardens, and open spaces fetched for Port Harcourt the additional name of "Garden City".

The people who habited the town of Port Harcourt had an envy-arousing knack for luxury and this feeling was so magnetic that it again was adorned with the name "Port Highlife". To this day, there is still that aura of pleasure-seeking in the inhabitants of this town. On the first creation of states in 1967, Port Harcourt added a new status to itself and became the Capital of Rivers state - a status it still claims till date.

Unfortunately, by 1967, it could not assume the role of Rivers state capital as it was in the hands of the Biafran government and was playing the role of the capital of Port Harcourt province of Biafra.

On its liberation, it abandoned Biafran role and became the River's state capital.

GEOGRAPHY

Port Harcourt is a town which comes under the influence of the S.W. monsoon wind - a rain bearing wind-across the atlantic ocean. It is under the influence of this wind all year round and ranks amongst the towns with the heaviest rainfalls in the country. Because of this heavy rainfall, and the oceans salinity influence, the area is covered mainly by Mangrove swamps and very dense forest types.

HISTORY OF PORT HARCOURT SITE

Before the 1966 Coup d'etat, the country's military set up was minimal. There was then no suspicion of any major internal strife or major external aggression. This situation thus, to my opinion, was in keeping with the military notion of minimum force!

During the first military regime, the military set up of the country was broken down into "COMMANDS" i.e. the Eastern Command, Western Command, Northern Command and Lagos garrison organisation.

The whole of Eastern region came under the Eastern command and it was the government of the then Eastern region that first earmarked the site for military occupation and use and two concrete structures were first put up there in 1966.

When eventually, the region became the Republic of Biafra, some more concrete structures were put up there and the site was owned by

the 7th Battalion of the Biafran Army.

After the liberation of Port Harcourt, the Federal troops still put the site to military use and till date, the site is still a military preserve.

SOIL DATA (KIDNEY ISLAND)

This soil date is a result of borings made in Kidney Island in Port Harcourt.

It is much more southern and right on the coast, than my site.

The soil type in Port Harcourt is generally of this layout with variations in the first two to three layers. In the case of my site, a 3m depth of laterite overlays the general pattern.

RESULT OF BORING

Generally between about 16.5m to 18.5m depth, very soft becoming soft to firm organic silty clay and peat becoming sand between 12m and 16m. A loose silty sand layer between 1.5m and 2.5m.

Ground water seepages were encountered in the boreholes between approximately 2.11m and 2.16m. depth.

CHAPTER 6

MASTER PLAN

The project is conceived from a military point of view.

The architectural approach will not make use of the tents which are more or less an acceptable picture for camping areas.

The task here is however, not to create a regionalistic architecture but to find new solution which are direct consequence of a realistic tradition based on existing traditional condition. An architecture that can be intergrated into the military fabirc. Consequently, with the knowledge of the fact that the infantry is a very important arm of the military due considerations were given to the things which are of primary importance to the thorough grooming of the infantry and a full utilization of the project.

In that regard, the projects site was zoned into three major land-use: (a) The military zone.

(b) The public zone

(c) The home stead.

It is very necessary to zone the site as above, since the zones will then call for adequate treatment by way of correct utilisation thereby facilitating the usage and justifying the essence of the project.

THE ZONES:

MILITARY ZONE: In view of the fact that the project is basically a military venture, it is pertinent to give a full demarcation to the military land-use whilst at the same time ensuring that it works along

with the other zones.

The military zone embraces all that is requisite to the military bearing of the project. These are (A) the teaching area which has the following components;

(1) classrooms

(2) library

(3) The signal centre

(4) The weapons' demonstration hall

(5) The Form Up Place (FUP)

(B) The confidence training section (as I call it) which in ordinary palluce is called the obstacle section and includes:

(1) The scale

(2) The 10 feet wall

(3) The 9 feet ditch

(4) The 6 feet wall

(5) The 3 feet ditch

(6) The rail

(7) The bridge

(8) The loop

(9) The barbed wire obstacle

(10) The tunnel

(11) The net

(12) A mini range

(13) An open area where some trainings like 1.5 activities, unarmed combat etc. can be carried out.

(14) The M.T. Yard where military vehicles are parked.

(C) The Administration area: This is the core of the organisation of the site and it includes:

(1) Reception area

(2) The general office

(3) The house allocation room

(4) Allocation officer's office

(5) Signal officer's office

(6) The C.J. (military) office

(7) The Adjutant's office

(8) The Commandant's office

(9) The planning hall

(10) The store officer's office

(11) The quartermaster item store

(12) The armoury

(13) The clinic.

(b) THE SECURITY HOUSE which houses the guardroom and gat house.

(2) THE PUBLIC ZONE

As it is also intended, in this project, to help the army out of its hotel accomodation debacle wherever the project is sited, provision has been made for those who normally would have been in hotels. As these soldiers are not involved in the mainstay of the project i.e. training, they are here being regarded as the "public." It is pertinent to note however, that these soldiers will be subject to certain military regulations which are binding on the trainers and trainees as it is also intended to bring them within the reach of the military claws as discipline tends to slacken when outside a military periphery.

The units under the public zone are not regimentally restricted

to whose classed public rather they are so classed indicating that they are open at all times to the 'public'.

The public zone has as its components:

(a) [illegible] UNIT: This consists of,

(1) Dining area for the trainees

(2) Dining area for the trainers and the displaced-from-the-hotels officers.

(3) The kitchen unit

(4) A shop for light items

(5) Indoor games room

(6) Barbers shop

(b) OUTDOOR GAMES AREA: This open area had facilites for lawn tennis and badminton.

(3) <u>THE HOME STEAD</u>

This zone bears the burden of accomodating trainees, trainers and the transit officers.

It is accordingly grouped to suit the users. Thus, a big section of the zone is laid out for trainees who with a population of two hundred men form a huge percentage of the population of the site users. This number includes the soldiers who are directly undergoing the training and those other ranks numbering about forty, who will also be involved in training the men and then in running the project like the kitchen, cleaning, bar attenders etc.

The trainers who are otherwise officers are grouped together with the transit officers in a section. The accomodation for trainers being different though.

The number of officers housed is seventy of which only fifteen are trainers and forty-five transit officers.

They are located such as to enable the transit officers whose primary affairs do not entail great involvement in the primary theme of the project, to be able to move in and out of the site without arousing attention of work-weary trainers.

The different sections in the home stead share a common outdoor games area and have a central-type of courtyard.

As trainees are not supposed to come along with cars, the parking facilities available in the site are closely linked to the trainers cum transit officers section.

The home stead also has the following space allocated to it: open space for prayers by moslems. The christains will use the classroom for their service. This provision is necessary, as the military respects to a fault, the religious leaning of personnels.

A space for a generator house which may or may not be used will be provided. In addition a laundry house will be provided.

THE SITE AND THE LAYOUT

THE SITE:

This particular project site is in the Bori Camp - a military acquired land - in Port Harcourt.

The site has been very poorly and very minimally developed. At the sametime, the development is not worth consideration when the architect or planner wants a totally free land space, as most of the development is shanty and decrepit.

The site is situated between latitude .... N and latitude ..... South and longitude .... E and longitude ..... E. It is generally a flat terrain.

Among the features linked to this site is the abandoned Port Harcourt airport, which has now shifted hence to the Nigerian Airport, and is West of site. Southern to the site is an oil exploration location which has a gas blowout that gives out an impressive illumination in the hours of darkness. To the west of the site are strings of villages which present, if not countered, potentials for infiltration by villagers. To the North is a long stretch of undeveloped thickly forested land mass which have patches of culturated areas. To the south is the Port Harcourt - Enugu Express way.

The site has had a long history of military occupancy - since after the 1966 coup d'etat in the country when the army was divided into commands i.e. Eastern Western and Northern commands with Lagos Garrison organisation.

From the Port Harcourt - Enugu expressway branches off a road which leads into the site and which at its end has another branch off due to the activities of soldiers who have developed shanties for their accomodation.

Being adjacent to the Port Harcourt water works, water supply to the site is broadly facilitated. Electricity supply is already being enjoyed in the 'developed' section of the site.

THE LAYOUT (PORT HARCOURT)

The site has a lead-in road which branches off from the Port Harcourt - Enugu expressway. Being an expansive site, I decidd to lay out my project in a 6 acre land size of the whole site thereby providing spaces for expansion and other activities like cross-country races, map-reading exercises etc.

The developed site is entered through a secondary road which yet branches off the main road to the site (see diagram).

The Security house fronts the site being adjacent to the main entrance gate which is one of the two gates in the wholly fenced developed area.

As was aforementioned the zones of the site are of some particular locations. Though there is no rigid demarcation between them. This results in a free flow of activities.

The lead-in road provides a direct access to the "working part" of the project i.e. the mess unit and the administrative block. A collector road branches off before the "working part" to give access to the education unit's parking lot which is expanded to form the MOTOR LAUNCHT YARD.

To provide access to the home-stead is a lead-out road linked to the exit. This also provides access to the FORE-UP-PLACE - assembly ground - games area, confidence training area and the area

for storage of prefabricated components of the project.

ORGANIZATIONAL CONCEPT

The development of an organizational pattern for a design program begins with observation of the characteristic activity pattern of users revealing a hierarchy of activity for which the program must offer a solution. Amongst the hierarchy of activity is the frequency of use.

This principle for instance places a library in the centre of a university and recreational facilities at the periphery.

Physical design is generally the result of the combination of three concept.

(1) Characteristics of site. This will lead to a special form.

(2) Physical form is a direct result of optimal organisation of activities in space.

(3) Architects attempt to accomodate the program in a predetermined spatial form.

According to Kevin Lynch in "Site planning" (MIT Press 1971), nine prototypes are common in use for layouts and I am adopting the "Hierarchical prototype" as it provides answers to most military/ architectural clashes.which are

(a) sudden massive expansion

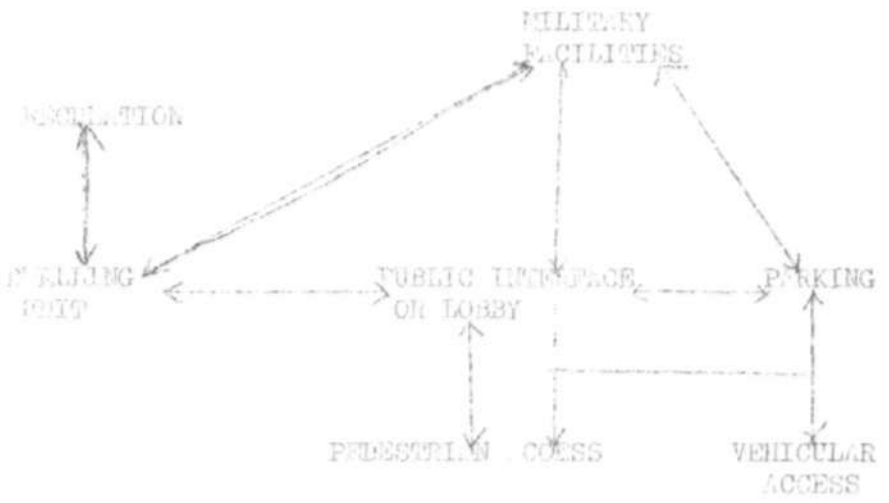
(b) sudden extension of existing form.

HIERARCHICAL
PROTOTYPE

In adopting this prototype, the central location is occupied by what I deem the working part comprising of the mess unit and the administrative building because these are the main core of activities judging by utilisation and importance respectively.

Around this core are located other activities like the accomodation units and the military zone.

SITE ELEMENTS AND THEIR RELATIONSHIP

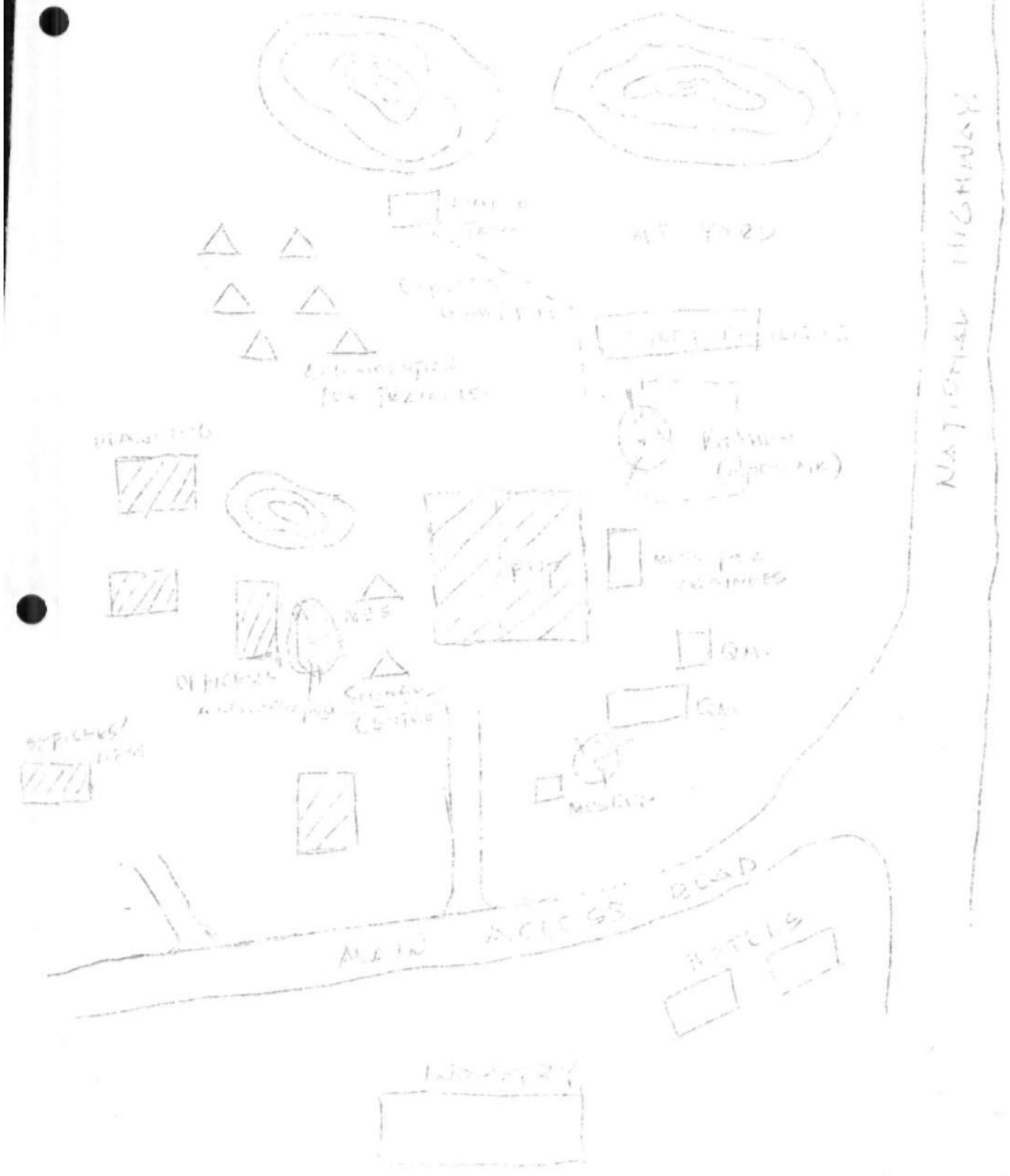


LAYOUT FOR HOT ARID CLIMATE

In laying out a program in the hot arid climate due consideration must be given to the factors already mentioned in the chapter on site planning.

The major problem in this climate however is to effectively counter solar radiation gain. This is achieved by placing the buildings in such a way as to create dense volumes with internal

CASE STUDY SKETCH
DIAGRAM



courtyards. The reason being that with such layout each building will shield the other from solar radiation (see chapter on forms).

I have tried to follow this idea in laying out my site in the hot arid zones.

Basically though, the organizational concept remains the same, with the working part staying the centre position.

CHAPTER 7

ADAPTABILITY

The project, primarily as is to be sited in the following places so as to tap their military potentials: Port Harcourt - Jungle and Marshland warfare. Calabar - Marine warfare and Marshland warfare. Jos - Mountain warfare. Sokoto - Desert warfare.

From the intended locations, it will be gleaned that climatic disparities exist. Infact the extremes of climatic conditions experienced in Nigeria have been involved. Port Harcourt is in the southern limits of the country and falls into the HOT HUMID CLIMATIC ZONE. Sokoto is also at the northern extreme of the country and is in the HOT ARID CLIMATIC ZONE.

I thus have the problem of designing a prototype training camp that can absorb the climatic differences in these areas and yet provide a very high degree of thermostable condition in the enclosed spaces.

It is pertinent here to mention that in these two extremes of our climatic conditions, some common design problems exist and these are those to be tackled by an architect involved in designing a

prototype for these climates as I have set out to do. These problems are: (a) Exclusion, to a very high percentage, of solar radiation gain.

(b) Achieving ventilation without necessarily resorting to mechanical devices.

(c) Avoidance of draught thereby, dust etc.

These are common problems to the two zones. It is being assumed that in designing with these two climates in mind, the project should be able to provide an acceptable usability in the intervening climatic conditions.

In trying to make out a design it is of interest to know how the common problems can be solved and attempts that have already been made in indigenous architecture to solve them, so that a rational decision based on this knowledge can be made with imperceptible flaws.

I shall write separately on the two climatic zones and then offer analogies and my achievements by way of how I have solved these problems in my architecture.

DESIGNS FOR HOT ZONES

In all tropical and temperate regions the radiant energy omitted by the sun has a pronounced effect upon the behaviour and durability of constructional materials exposed to it.

The effect of solar radiation can be considered in two separate aspects, thermal and photo-chemical, though in practice the two effects are always readily separable.

Solar radiation during its passage through the atmosphere is partially absorbed, scattered, diffused, reflected by air, water-vapour dust and cloud.

Though much of the radiation is depleted, a good proportion reaches the earth's surface as long-wave radiation and has considerable effect on nearby buildings that are adjacent to paved surfaces or sand. Thus such surfaces should be avoided in designs for hot zones.

It should be noted that in these regions the following factors primarily affect the design for comfort of buildings:- solar radiation, levels, temperature variations (day and night) varying winds, rain conditions and the distribution of land and water.

SOLAR RADIATION AND HEIGHT

It has been assumed that intensity of solar radiation increases with height. This effect is however not so marked.

HEAT PENETRATION:

Researchers based on experience, have stated that inhabitants of hot dry climates can work efficiently and healthily under conditions of temperature stresses above the physiological comfort level, if they can sleep well and authorities believe that sleeping comfort is attainable at temperatures of 85°F along with an air movement of 50 feet per minute.

This concept of equalization of temperatures during the night-time in an enclosed shade is attainable without difficulty.

Thermal conductivity, volumetric specific heat, solar absorptivity, low temperatures emussivity and moisture absorption are the properties related to the thermal behaviour of materials and knowledge of these go a long way in helping to achieve a good design.

HEAT CONTROL: The first line of heat control lies at the surface.

Since the surface temperature of sunlit material will be higher than that of air, air movements over an exposed surface will reduce the external heat impact and are particularly beneficial under hot conditions. The exchange effect can be increased by diluting the radiation over a large area by many means of which corrugated surfaces is one. This effect I aim at achieving by using, for my external facades, corrugated asbestos surface.

The heat quantity entering a building is influenced by the heat transmission of the enclosing walls, roofs and other exposed parts of the building. Thus an effective counter to their absorption of radiation heat could go long way in providing thermal comfort in the structures.

The section of my wall panel shows four distinct layers and heat movement is much impeded by multi-layered sections of walls, roof and other building sections. The section of my roof truess also shows three distinct layers with huge space for air circulation and consequently the ventilation of the roof.

TYPES AND ELEMENTS OF CONSTRUCTION

For centuries a thermostable condition has been the design goal of builders. It has been found that building styles are defined less by national frontiers than by climate zones. Allowing for some variation in local taste and tradition, the general forms of native habitation are born of the environment.

Also, the proportion of solid surfaces to openings in the exterior facades depends as much on popular psychology as on climate and the materials used.

HOT ARID ZONE: 15° - 30° LATITUDE

In this zone, the existence of clear skies due to low humidity leads to intense radiation exchange resulting in extreme temperature variations between day and night and consequently, the main theme of design in this zone is the exclusion, to a large extent, of solar radiation gains.

Native habitations in this zone have achieved thermostable condition throughout age by the use of, domes and vaults as roof shape with massive structural materials. Some habitations, like the troglodytes of Algeria and Tunisia, were sunk into the ground to utilise the soils mass as infinite wall thickness.

Weight of construction does not govern indoor conditions alone: forms and shapes also impose strong influence. Massive shapes are advantages, cubical forms or those slightly elongated towards the east-west are most adaptable.

It is assumed that the square, which combines the largest practical volume with the smallest outside surface, has the best ability of achieving a thermostable conditions. This is viewed now, as being correct for older buildings with small openings but not for comtemporary buildings with flare for large openings. The thermal impacts on the interior of the building should be computed on a quantitative basis.

The attached figure shows basic forms usable in hot arid climate. (see diagram).

Massive wall construction has been the most popular type of construction in the Hot arid zone because of its ability to control

thermal flow resulting from its time-lag ability.

Light wall construction possibilities however, exist in this region too. When this is used, it is viewed as replacing the massive load bearing construction with structural members devoted to load bearing and covered with a skin (curtain wall); performing the role of a filter between the outside and the inside also controlling the intake of air, heat, sound and odours.

My design which is of such light weight construction tries to use an insulating material (asbestos) to sandwich an insulator (cork or wood fibre boards) to make the outer skin, the aim being that of achieving a very high degree of thermal comfort in my habitable spaces without employing such added elements as sun-shading devices.

In hot arid climates, even if buildings are thermally well adapted, ventilation, proper illumination avoidance of glare and ceiling heights also affect the comfort in buildings.

NATURAL VENTILATION

Much as the possibility of using mechnical cooling devices exists, natural ventilation means can still afford habitations adequate comfort by way of maximising the advantage of natural air-movement.

HOT HUMID ZONE

The basic idea to a comfortable habitation space in this area is having a lightweight enclosure with adequate ventilation et al.

The treatment of hot arid zone as described already, very much suits the hot humid, zone, with little adjustments.

CHAPTER 8

HOT HUMID REGION

Detailed Analysis: Temp: The region is characterised by small temperature variation. The monthly temperature range is 22°F through the year. The daily temp variation is only about 6°F in summer and 13°F in winter.

SUN: Summer cloudiness acts the intensity of solar radiation. It builds up during the hot part of the day, reducing solar input. Large proportion of diffuse radiation. Shaded conditions are required nearly throughout the year.

WIND: Average wind velocity 10 mph. comes from N.W. direction both in the morning and the afternoons. The large part of night hours and evenings are mostly calm or bring only light breezes. Northernly winds are common from October through March. Sea breeze and trade wind combination may reach 20 - 30 mph. on summer afternoons with stronger winds on hottest days. Strongest winds are generally under 50 mph.

PRECIPITATION: The average yearly rainfall of about 60" comes principally in summer months.

RELATIVE HUMIDITY AND VAPOUR PRESSURE: The average yearly vapour pressure is nearly 18mm Hg. From July to October the daily conditions are to over 20 mm Hg; a situation where conditions are hardly bearable without a breeze. 25% of the year is in such an extremely uncomfortable range. A further 50% is still in vapour pressure areas where air movements are required to restore the feeling of comfort.

HOT HUMID CLIMATE

BUILDING ELEMENTS

OPENINGS AND WINDOWS

Customary distinction between wall and openings disappears. Ventilation is needed 85% of the year. E - W cross ventilation is essential. Structure must be sheltered from sun and rain. It must be shielded from sky radiation and glare.

WALLS -- Walls have less importance here than in any other region. They are used primarily for screening from insects and for their flexible wind penetration qualities rather than as thermal barriers.

ROOF -- Strongest thermal impact occur here. The design emphasis changes from walls to roof. A ventilated double roof is desireable. The upper roof functioning as sun protection. It must be water-tight, insulated and reflect solar rays. A wide overhang is necessary for rain protection and reduction of sky glare (rain comes at 45° angle).

MATERIALS. Light heat capacity walls are best for thermal lag may cause night re-radiation of heat and morning condensation. Prevention of deterioration of materials by moisture and animals sources is necessary.

SHADING DEVICES: Sunbreakers are necessary because of powerful radiation mainly on E - W sides. The west wall gets more radiation impact in summer than the south wall.

FOUNDATIONS & BASEMENT. Basement is impractical because of constant high humidity. Foundation must be protected from moisture, mold, fungus etc. Building on high stilts provides better ventilation in living areas and can create a sheltered area below as well.

HOT HUMID CLIMATE

HOUSING LAYOUT

SITE SELECTION: High elevations on windward side are desirable; specifically, locations near crest slightly offset from prevailing wind direction receive most air movement. Southern and Northern slope directions are better than E and W sides are preferred because of less radiation.

TOWN STRUCTURE: Emphasis should be on separated houses to utilize air movements. A shaded environment becomes an important consideration. The character of the town should be loose and scattered.

LANDSCAPE: In the generally flat areas the integrated use of water is both possible and desirable. Water drainage must be provided away from house, grading, also must be provided for run-off of intensive rainstorms.

VEGETATION: Shade trees should be high-branching so that they do not interfere with breezes. Low vegetation must be kept away from houses so as not to block air movement. Air coming into a structure from a shaded lawn is desirable.

GENERAL OBJECTIVES IN THE HOT HUMID CLIMATE: Reduce head production; Reduce radiation gain. Promote evaporation loss.

SHELTER DESIGN

HOUSE TYPES: Individual, preferably somewhat elevated, house types are advantageous. Freely elongated, high buildings are preferred with a loose density.

GENERAL ARRANGEMENT. Buildings should be shaded structures which encourage cooling air movements; shade protection should be on all sun-exposed sides, mainly on roof and E and W exposures.

PLAN: As temperatures are not too excessive, free plans can be evolved as long as the house is important. Plans might be organised into separate elements as 75% of the time, outdoor conditions are near comfort, if shaded. Paving should be avoided. Screened areas are necessary to keep out insects. Heat and moisture producing areas should be ventilated and separated from the rest of the structure.

FORM; VOLUM: Strong radiation effects on the E and W sides elongation. The optimum shape is 1:1.7 but upto 1:3.0 on E - W axis is also acceptable. A volume effect is undesirable.

HOT ARID CLIMATE

Climate and Design Considerations

(1) Layout. Buildings should be orientated on an E - W axis, the long elevations facing North and South to reduce exposure to the Sun.

(2) Air Movement: Generally rooms should be single banked with windows in the North and South walls to ensure air movement by ample cross ventilation.

(3) Openings. These are to be medium sized.

(4) Walls: both external and Internal walls should massive

(5) Roofs. should be heavy with subtantial thermal capacity with giving a time lag of at least 8 hours.

(6) Outdoor Sleeping: Between the months of April and May, the climate is usually such that people prefer sleeping in the open. Patios and verandahs could be provided for this.

HOT ARID CLIMATE

HOUSING LAYOUT	SHELTER LAYOUT
SITE SELECTION: On NE - E Slope exposures, lower portions preferred, where cool air flow effect can be utilized and controlled. High attitudes and locations with evaporative possibilities are advantageous.	HOUSE TYPES: Compact 'patio' house type is preferred, adjoining houses, row houses and group arrangements (all continous in E - W axis) which tend to create a volume effect are advantageous. High massive buildings are preferable.
TOWN STRUCTURE: The walls of houses and gardens should provide shade to outdoor living areas, similar to the effect of horizontal 'eggerate' devices. Unit dwellings or groups should create patio-like areas. Concentration is desirable. The town structure should thus react against heat with a shaded and dense layout.	GENERAL ARRANGEMENT: Heat loss rather than gain is the objectives therefore, closed building arrangements around green areas are preferable utilizing evaporative cooling effect and night out going radiation losses. Lythosphere arrangements are here applicable ie. sub-terranean utilization. High ceilings are not necessary. Outdoor sleeping possibilites should be considered.
PUBLIC SPACING: There should be a close connection between public spaces and residential areas. Half and full shade protection is desirable, paved surfaces should be avoided, pools of water are beneficial	PLAN: Inward looking layout can benefit from microclimatic advantages. Walled-in house arrangement can benefit from cool air pool effect. Single floor and a convenient plan with economy of movement avoids heat gain. Evaporative possibilities should be utilized. Heat producing spaces should be placed on west side to baffle sun impact.
LANDSCAPE: As vegetation is generally sparse, concentration of plant and grass covered areas in the manner of an 'oasis' is desirable.	FORM; VOLUME: Compact shapes are preferable yet somewhat elongated on E - W axis. The optimum shape is 1:1.3. Volume effect is important. Building forms should have minimum solar projection.

HOUSING LAYOUT	SHELTER LAYOUT
VEGETATION: Vegetation is desirable both as a radiation absorbent surface and for its evaporative and shade giving properties.	INTERIOR: Deep room arrangements can be used as a cooking contrast to intense outdoor heat. Use of low enussurity "cool" colours reduces heat reflection on interior surfaces. Connection with patio areas has cooling effect on adjacent spaces.
GENERAL OBJECTIVES IN THE HOT ARID REGION: Reduce heat production. Reduce and promote loss of radiation. Reduce conduction gain. Promote evaporation	

BUILDING ELEMENTS

OPENINGS AND WINDOWS: Relatively small openings reduce intense radiation. Windows should be shielded from direct radiation, and set high to protect from ground radiation. Openings should be tight-closing as protection against high durnal heat. External shades are prefered. Openings should be located on S, N and , to a lesser degree, on E sides.

WALLS: Walls of daytime living areas should be of heat-shoring materials. Walls of night use rooms of materials with light heat capacity. E and W walls should preferably be shaded. High r lf reflective qualities are desirable for both thermal and solar radiation.

ROOF: Generally heat storage insulation is best, which was the flywheel effect of outgoing radiation for daily heat balance. However, a shaded ventilated roof is also applicable, primarily over night-use rooms. Water spray or pool on roof is effective. High solar reflectivity is a basic requirement, emussivity is essential long-wave radiation.

MATERIALS: Insolation index is 45°. required insulation value relative to 5 is: E - 1.1; W - 1.2; N - 1.0 roof 1.6. 0 High heat capacity walls are essential. Necessary time lags for internal heat balance are E - 0 hours; S - 10 hours. W - 10 hours N - 10 hours or no lag; Roof - 12 hours.

SHADING DEVICES: Devices should be separated from structure and exposed to wind connection.

FOUNDATION; BASEMENT: Lythosphere type of houses are applicable in this zone.

SOKOTO - CLIMATIC INFORMATION

Sokoto, a town which falls into the areas zoned as the hot and dry region in world geography was chosen as my example of the hot and dry location for my project. The climatic data is expected to help in considering the best way to contain the problems of solar heat in my project if it is to be sited in a location of similar climatic problems.

CLIMATIC DATA

Temperature: Daily range (average)	20°F or more. May exceed 40°F.
Day time air temperature	Up to 100°F or more
Night-time temperature	Usually above skin temperature of human body. Harmer period: 70 - 75°F; cooler period: 50 - 65°F.
Annual range	20 - 30°F. At tropics may exceed 30°F
Sky temperature	Depends on dust in sky; when clear below air temperature
Humidity	7½ - 15 mb: In rainy seasons upto 20mb.
Vapour pressure absolute humidity relative humidity	10 - 55%
Rainfall: Annual rainfall	Slight and variable. less than 10" (30cm)
Other characteristics of rainfall	Flash storms in which up to 2" (5cm) may fall occur occassionally.
Sky conditions: General appearance	Vapour in sky may be replaced by dust, then sky, particularly towards horizon, bright. In sandstorms, sky darkened by dust.
Soil moisture	Ground very dry. Dries rapidly after any rain. Waterable deep or non-existent.

Ground conditions general appearance	Little vegetation: ground and rocks, brown or red.
Air movement	Wind usually hot or warm, risk of whirlwinds or tornadoes stiller at night than in daytime.
Other characteristics	High sun temperature and rapid cooling at night may cause materials to crack and break up.

CHAPTER 9

ARCHITECTURE OF THE PROJECT

Architecture has been broadly defined as the organisation of space, in a coordinated form, to serve a particular purpose for which the design was conceived. In doing this, a volume is enclosed by a floor, a wall and a roof.

This is basically my idea of architecture - simply solutions to almost any problem!

Like was aforementioned, to organise a space architecturally, three concepts working in combination. These concepts (once again), are:

(1) Characteristic of site. This will lead to a special form.

(2) Physical form is a direct result of optimal organisation of activities in space

(3) Architects attempt to accomodate the programme in a predetermined spatial form.

In arriving at my design, three major considerations were made.

(1) Climatic consideration

(2) Production and erection considerations

(3) Military considerations.

CLIMATIC CONSIDERATIONS

My project is intended to be able to adapt to the climatic situation of the two broadest climatic regions in Nigeria namely:

HOT HUMID CLIMATE and

HOT ARID CLIMATE.

In these climates, some major problems are to be solved in designing for them namely:

HOT ARID REGION:

- Reduction of heat production
- Reduction and promotion of loss of radiation
- Reduction of heat conduction gain
- Promotion of evaporation by say use of fountains, pools etc.

HOT HUMID REGION:

- Reduction of heat production
- Reduction of radiation gain
- Discourage evaporation.

In attempting to design a prototype for the climatic zones combined the architect has to ensure that a good compromise is arrived at. (To do this, acquaintance with how traditional architecture has solved these problem is very essential. (See chapter 7 on Adaptability).

In summary, traditional architecture and infact modern designers and researchers have arrived at the conclusion that a 1:1.3 - 1.7 ratio of shape provides the best solution in hot arid region.

In the Hot humid zone, freely elongated buildings are most suitable.

In all thus, a rectangular plan mostly adapts best to the climates.

PRODUCTION AND ERECTION

In a project of this sort where the architect provides the design brief, he strives for high standard in terms of quality, durability, low maintenance cost etc.

To achieve the above, I have used a prefabrication system

which I feel will ensure that the army finances for such projects are more utilised as

- more skilled labour is employed
- Engineering manpower is tapped
- Contractual gains made by civilian contractors will be minimised.
- Standardization of components will save a lot of wastage
- There will be reduction in maintenance cost.

In designing a prefabricated structure the following objectives form the design base:

- Simple and quick to erect on site
- Ideal for transportation (not susceptible to damage, well stacked, light, conveyable by available vehicles etc).
- Contains an economical number of different components.
- Meets the functional requirement of structure and roof fully. Prefabrication system.
- Possible re-use.

in achieving the above aims cannot be designed with complicated shapes and forms. The simplest of forms are the most acceptable in such systems such forms being mainly rectangles, squares and seldomly triangles.

This limitation is broadly reflected in my architecture.

MILITARY CONSIDERATION

Military considerations have played a big role in influencing my architecture. Basically the architecture of the "Parade Ground" which is rectangular, directly or indirectly affects the architecture of structures in most military institutions.

Structures either run along or perpendicular to the parade ground and are mostly conforming to its dictates plan-wise.

The military life is most uncomplicated and we as soldiers, are trained to be open and straight in our dealings. This idea is reflected in our architecture which is of the basic form square or rectangle.

I was thus faced in this wise with the problem of accomodating my programme in an already predetermined form.

Generally there the square and the rectangle showed up as the most acceptable of forms for my project.

To therefore, arrive at an architecture that can offer an agreeable solution for the two climates whilst working within the above enumerated limitations, and at the sametime not having the functions scattered like droppings, I had to ensure that related functions were tied together. This I achieved by using extensively, COURTYARDS.

This idea of courtyards from climatological bearing, has its advantages amongst which are:

(1) Micro-climatic effects which influence the airflow in adjacent spaces.

(2) With the courtyards, openings can be, depending on the courtyard treatment, placed on the western facade.

(3) The courtyard can be treated, in an impressive manner, to become the best space within a complex and can then be used as a mini park etc.

CHAPTER 10

WHY PREFABRICATION

The infantry arm of the Nigerian Army and infact of any army is essentially a very mobile arm needing speed in all its dealing.

The mobile nature of this arm of the army implies having items of movable nature.

In designing for training, considefation was given to the fact that a training camp site can be lifted from one site to another for many reasons of which one is the utilisation of some qualities of a terrain that is within an economic distance from an existing site.

With this in mind, it became essential, if the project will be viable and of good use to the Army, to have mobility in mind while designing a project of the sort.

Such mobility can be achieved by structures that are able to site with minimal work like in excavation, and then the building being able to offer shelter in the earliest time possible.

This in essence calls for Prefabrication and thats what I have done - prefabricating all the elements for my project.

UCOLAD-J SYSTEM

This is the name of my prefabrication system.

Ucolad-J system uses light steel frame to which prefabricated cladding elements are fixed.

DIMENSIONAL COORDINATION

The structural grid is 4m x 4m with stanchions located at any intersection of the square grid and where the intersections are within

usable spaces, the location of stanchions are relegated only to the periphery walls.

Supplementary structural grid of 2m x 2m and 1m x 1m are provided for to avoid 4m jumps where such size of space will be wasteful.

Partitions are located on structural grid or centrally between grid line.

The cladding elements are located between the stanchions flanges to enable flushing of stanchion cover piece with external facing of the panel.

HEIGHT

Floor to ceiling height is 2.9m for spans upto 8m. and 4.5m, and 6m for spans upto 12m.

STEEL FRAME

The elements are I - section stanchion, wall balancer and threshold element.

STANCHION:

Normally 8cm square I - section steel. Stanchion cap plates are drilled to receive ends of wall balancer, and threshold elements and the roof truss.

FLOOR BEAMS

Are of precast reinforced concrete 199cm in length. Slotted into the I - section and resting on the internal supports at 2m centres. Intermediate beams are connected to the beams in the stanchion gaps. The Floor beams are 10cm in depth.

WALL PANEL (EXTERNAL CLADDING AND PARTITION). Made up of double skin 4 cm asbestos sheets sandwiching a 3cm insulating wood chip boards for the panels for the hot humid climate. The panels for

hot dry climate comprise 4cm double skin asbestos sheets sandwiching 8 cm of insulating woodchip boards. External face of each panel is corrugated.

PARTITION: Consist of 2cm double skin absestos sheet sandwiching 3cm of insulating woodchips board.

The wall panels are prefabricated according to the size of the structure and three types exist: one with door, second with window space the third with none.

ROOF TRUSS

This is made up of light steel angles bolted to two steel channels at the end with steel angles as ties.

The channels have bolt holes for connection with adjacent trusses.

FOUNDATION: Made of reinforced precast concrete 1:2:4 mix. Fashioned to be footing to stanchions. Has a 30 x 30 x 40 shaft with a 20 x 50 x 50 base to act as weight spread and prevention against ground water disturbances and rain water seepage disturbance.

STANCHIONS: Normally I-section steel, normally 8cm x 8cm with steel plates welded to the head and leg of the stanchions with bolt spaces to receive ends of wall balancers and roof truss.

CEILING: Consists of special design channel drilled at the head to receive wire hooks which are tied to the roof beams and trusses. An insulating ceiling board of polystyrene foam is supended from the channel. The whole underface is covered by plastic strip.

This is a product of General Metal Product Limited and in view of the fact that it is easy and fast to assemble, and well insulated, I adopt it as my ceiling item.

CHAPTER 11

ROOM DESIGN

The design of individual rooms or buildings is determined to a large extent by their internal functional requirements.

DESIGN METHOD: The first step in making a design for either a building or each room within or building is to establish the design criteria or the functional requirements which the building must satisfy in order to operate smoothly. It then takes two particular useful tools to transform the functional requirements into a building design.

(a) RELATIONSHIP DIAGRAM: Each room within a building or item within a room is given a diagrammatic shape. These shapes are then positioned relative to one another in accordance with the design criteria. The arrangement most nearly satisfying the criteria then forms the bases for making a floor plan

(b) The second design tool is a device known as a building module which is a grid whose coordinate spacing relates to common dimensions used in design and construction. By positioning walls, doors and windows on gridlines of the module the design can be rationalised making the eventual construction simpler.

My coordinate spacing is 2.0m as my major grid this being based on the basic human scale as the only parameter - I think - of assessing rom space requirements for soldiers. This is in line with the incomplex nature of the soldier.

A structural grid of 4.0m is in use too as this is viewed as the least spacing allowable for the structure I am using - light

steel. I am making provision for a 1m grid as this will help in facilitating the placement of the prefabricated compnents into the fabric of the building when this is either in excess or smaller than the 4m grid. This also agrees with the main prefabrication length of the wall panels.

THE HUMAN MOVEMENT: The flow of human users in the site can simply be described thus:

- Users cross the Gate house and arrive at the vehicular bay in front of the mess unit and administrative building.

Depending on the cadre of the person and his objectives, he either goes into the administrative area, the mess unit or detours to enter the accomodation units.

Access to car parking facilites is left open only to trainers and other officers. The trainees are supposed to be on training without cars.

An open area between their buildings and the access road however, could provide this category of users with parking facility if the case so demands.

Access to all accomodation units is by foot.

The users could use the collector road out of the site.

THE UNITS

EDUCATION

This unit caters for all the academics that happen in the site. The classromm is provided to enable the teaching of the theories of military doctrines, of war et al.

The library affords the camp opportunity to store military annals, publications and for reading these publications. This is very necessary as our tactics can be fashioned after the analysis of already used tactics.

It also provides for weapons demonstration. The use of this space is to ascertain that all trainees are very conversant with the handling of all equipments available to them. The unit also has the communications room which forms an electronic link between the camp and all other military set-ups.

An assembly area is particularly vital in military institutions, I have linked the assembly area of this project to the education unit as it is the area mostly in need of such a facility.

The assembly area which I call the form-up-place, is also aimed as serving the purpose of assembly in case a high ranking officials visits the location.

ACCOMODATION UNITS

There are principally three accomodation units.

(a) For trainees

(b) For transit officer displaced from hotels

(c) For trainers.

TRAINERS UNIT

This is designed to provide, for every threee bedrooms, a toilet facility.

There is a bit of space area difference in these room. This is so, to satisfy the hierachical inclination of trainees who are supposed to be non-commissioned officers as it is these people

that actually exhibit the hierarchy for which the army or military seems to be very popular.

In all designs of the accomodation units, efforts were made to avoid the placement of windows on the western side of the structure. This been in an effort to avert direct sunlight into rooms and also to avoid to an acceptable limit the use of any sun-shading devices.

In courtyards which provide shade however, windows could be placed in the western facade.

The overall idea of providing single rooms for trainees involved in this kind of training could be viewed as distasteful and in bad faith by some people arguing that it will make them unserious soldiers.

This in no way should be so because; (1) The toughening of a soldier comes from the training he undergoes and not from where he sleeps or on what he sleeps.
(2) The basic difference between a soldier and a civilian is the uniform and the training the soldier gets so, trying to reduce a soldier to a little above a beast in the forest is viewed as unfortunate by me and so I am providing such amenities for these people who have given up their lives for our nation.

TRANSIT OFFICERS

These people are not involved in the training schedule. I have however, brought them into the camp, to (1) discourage their over exposure to curlian life as this results in slackened discipline (2) To save cost of keeping them in hotels so that the fund could be channelled to more paying military ventures.

(3) Cut short the notion of plenty that one imbibes while staying in a hotel, and to bring to pay for some of their consumed items by way of, say mess bills.

In arriving at the space allotted them, I took into consideration what they are provided with in hotels - self-contained bedrooms.

I decided to provide them with a living area and bedroom of minimum areas, with toilet facility for each living unit.

These units are not supposed to provide permanent accomodation for these officers.

TRAINERS

This class of users are in two categories - the officers and the non-commissioned officers.

In the case of the non-commissioned officers, they will share the same accomodation type with the trainees but depending on their rank, they could get upto a three bed space unit, that is one group of the design.

In the case of the officers, they have basically a two bedroom unit which can be expanded to three bedroom unit by merely fixing up space according to the provision I have made. The unit will have also a kitchen facility.

This is so because all other users are non-permanent occupants whilst these officers have the training schools as their main military units.

At this stage of the design, I am making use of: (1) 201 men as trainees (2) 20 men as trainers (3) 50 men as transit officers.

If a stage is attained when the case of hotel accomodation for officers is totally phased out and all transit officers are accomodated in say barracks, a problem then arises on what to do with their accomodation units in my camp. The problem is tackled thus: The strength of users is increased which implies incfease in trainers strength too.

Trainers are then allocated accomodation according to marital status. Single officers will still use the accomodation for transit officers.

The remaining structures, if any, are demounted and either stored for repairs or shifted to other military set-ups that require such components for their structures.

THE TEMPORARY STORAGE FOR COMPONENTS

This is almost the most important structure in the site as it is the first to be erected and then used to store components which are used for erection of structures.

Designed and constructed along the idea of the whole structures, this is specially handled to adequately exclude rain and dampness around it.

ANCILLIARY FACILITIES

To supplement use of the main structure and the general comfort in the site, some facilities are provided. Amongst these is the laundry.

As users will be fully engaged in the 16 week duration of their stay, they require a general laundry if smartness by bearing

is still to be expected of them.

The laundry also serves the trainers and transit officers.

Amongst the provisions in this general laundry are: lobby, dirty linen,room, store, changing room, toilets, washing room, drying area, ironing room and collection room.

THE MESS UNIT

In all institutions the mess unit (catering) experiences the greatest number of people cumulatively in a day. It therefore has the capacity of accepting noise et al. Generally, the mess unit includes the dining and the bar and the kitchens.

I have decided to include the indoor games and shopping facility in the mess unit to mass together the noise generating spaces.

This being this major concentration area on the average, I have decided to make it directly accessible from the outside for visitors, and to tie it to the accomodation units well enough to facilitate linkage between the two areas.

ADMINISTRATIVE BUILDING

This is the organisational core of the camp. It has basically the offices and the planning/conference room.

I have decided to include the arms and quartermaster items store in this building so as to enable the commandant, whose window scans the two allocated spaces, to have a complete surveillance of them as they have become very strategic locations.

The clinic is also included in this complex so as to utilise the intimidating stance of the commandant and officers within the complex to elicit the quiet that is needed in a clinic.

This clinic is also supposed to provide admission opportunities for six persons. This became imperative as the project could be sited far away from a major medical institution. People thus should be afforded chance to recover from some ailments before adequate medical care will be given them.

SHOPPING:

Military institutions have been known to give 'birth' to market scenes which eventually got nicknamed to 'mammy markets'.

These markets in almost all cases are roughly run in ramshackle sheds and most often in open air.

Their presence threatens the very institutions that gave them life as they most often get out of size and thus give an immilitary atmosphere to a military institution.

Till of recent, it was known that wives of soldiers bring about these 'mammy markets'. The recent incursion into such a "priviledge" by civilian petty traders threatens even the base of the military as a lot of nefarious activities, which will be difficult to put in check could be perpertrated (not necessarily robery).

However, 'mammy markets' come up where there are wives.

Unfortunately, there will be no wives in my planned project as it will be strictly military and for training purposes.

Providing a shopping centre (no matter the size), which is organised and run by soldiers detailed for that, will help alleviate some purchasing needs of the camp users and also make for the atmosphere to remain military.

It will also help discourage the chances of these "satelite

markets" springing up around the site.

CHAPTER 12

SCHEDULE OF ACCOMODATION AND SPACE REQUIREMENTS

To ascertain the spaces needed in my kind of project, research into an existing similar project becomes imperative. Unfortunately the projects that exist are either below the scope of my project or much more wider in scope. I was however compelled to research into the space requirements and utilization in the two cases so as to arrive at a space allocation, which to my judgement is rational. This of course will not be an excellent decision.

In conducting the research however, the following sequence was used: -

(1) Tracing the demand and utilization pattern thereby formulating a flow diagram for the project.

(2) Researching into users behavioral pattern so as to ascertain how the placement of functions will be most justified.

(3) Establishing design models on proposals from which the required areas will be calculated.

(4) Calculating the service capacity of each building

(a) DEMAND PATTERN: The demand pattern for the various services catered for in the institutions can be viewed in terms of type of training and other activities to be carried out in the site. Evidence shows that pattens of use are affected by the following variables:

(1) Organisation of space.

(2) Duration and time of use

(3) Hierachical ideas of the military

To achieve my design goals, I have made some compromise particularly in regards to the idea of Hierarchy.

In trying to provide for officers to be displaced from hotels, I have assumed an average of fifty for all the locations. Some locations obviously have a bigger number than this whilst the opposite is still true for other locations.

(b) BEHAVIORAL PATTERN:

In such a project as mine, the behaviours of users is mostly affected. Being cut off, so to say, from the relaxing atmosphere of the barracks etc. these users have a circular type of life style: Wake up; go to the mess, go for training return to base, go to the mess again; sleep.

In this regard the mess and the hom (accomodation) become the main consideration.

Generally, misdemeanours can be discerned from these users as they are mostly tense. They could also become noisy. In view of this, areas like the clinic which requires quiet is placed near to the commandant whose posture is most intimidating and therefore effective in eliciting the required discipline no matter one's discomfort.

(C) DESIGN MODELS: Three space types are conspicuously discerned in military institutions of my type

(1) The working part i.e. mess and administrative block

(2) The accomodation units

(3) The teaching cum training facilities.

The accomodation area is most densely populated and adequate consideration in terms of internal and external spaces must be given.

The training area is most sparsely used but the tie-ups to it implies large space area.

(D) SERVICE CAPACITY:

The service capacity of each building is determined primarily by the capacity of working staff and users and also by the equipments, supply and available space. In ascertaining the number of staff, I took an average of the number of staff used in the surveyed institutions and sylogistically related the average to the anticipated population of my camp.

SPACE ALLOCATION

RECREATION:

INDOOR games: 2.0 m^2/person

Assume average attendance of 18%

= 50 people.

Space area = 100 m^2.

OUTDOOR games

Badminton (2 courts) 11.6 x 2 m^2 = 23.2 m^2

Lawn tennis (2 courts) 11.1 x 2 m^2 = 22.2 m^2

Volley ball (2 courts) 15.8 x 2 m^2 = 31.6 m^2 = 77 m^2.

Viewing or relaxation area around the courts 1 m^2/person.

Assuming a maximum of 100 people. =

= 100 m^2

Total area = 177 m^2.

MESS.

Dining 1.5 m^2/person

Assume 71% attendance at once at peak hour

= 192 persons. (106 persons for trainees)

= 288 m^2 (Two dining areas for officers and for trainees)

R.R: 0.7 m^2/person

Assume 50% at any point in time.

= 137 persons

= 96 m^2

(toilets, circulation, servery etc)

BARBERS SHED

8.0 m^2/bay

providing for 6 bay.

= 48 m^2

SHOP 80 m^2

STORE 32 m^2

LOBBY 48 m^2

KITCHEN 40% of total dining area 115 m^2.

CHANGING AREA (Cubicles, circulation, services) 40 m^2

MATERIALS STORE = 96 m^2

OUTDOOR PREPARATION = 80 m^2

CIRCULATION = 368 m^2

Courtyard = 324 m^2

TOTAL = 1457

EDUCATION UNIT

Classroom	=	96 m^2
Library and Magazine room	=	72 m^2
WEAPONS DEMONSTRATION HALL	=	96 m^2
Exchange and TRA series rooms		60 m^2
SERVICES	=	24 m^2
Courtyard and circulation		190 m^2
		538 m^2

ADMINISTRATION:

Clinic	=	160 m^2
Conference	=	72 m^2
Offices	=	204 m^2
Gun stores	=	80 m^2
Arms stores	=	48 M^2
Circulation	=	152 m^2
Services (reception, toilets etc)		80 m^2
Courtyard	=	288 m^2
TOTAL		1084 m^2

SECURITY

Prisoners room		12 m^2
Services	12.	12.5 m^2
General rest room		14 m^2
Guard room		4 m^2
Lobby		4 m^2
Total		46.5 m^2

LAUNDRY:	Collection	12 m^2
Lobby	6	m^2
Dirty linen	16	m^2
Store	16	m^2
Circulation	12	m^2
Changing	6	m^2
Washing	24	m^2
Services	6	m^2
Ironing	16	m^2

CHAPTER 13

BUILDING CONSTRUCTION

Considering the general orientation of soldiers, buildings for the army should be of high standards in terms of QUALITY, LOW MAINTENANCE COST, DURABILITY etc.

Functionality could override aesthetics in military designs. This does not however suggest the acceptability of drab aesthetics.

The "adaptable units for the Nigerian Army" consists, structurally, of frame and wall panels. It has pad foundation onto which is sorewed the steel I-section stanction.

The roof is made of a specially designed light steel truss bolted to the upper end of the stanction and covered with aluminium roofing sheet.

The frame being in place, the external wall panels are placed and the space so formed is then partitioned by partitioning panel.

The different components of my prefabrication are here discussed.

Foundation: Precast concrete pad foundation is used as only point load weight transmission is expected from the super structure.

The reinforcing rods of the pad are projected to serve as bolts to the column steel plate with already drilled holes to accept the rods.

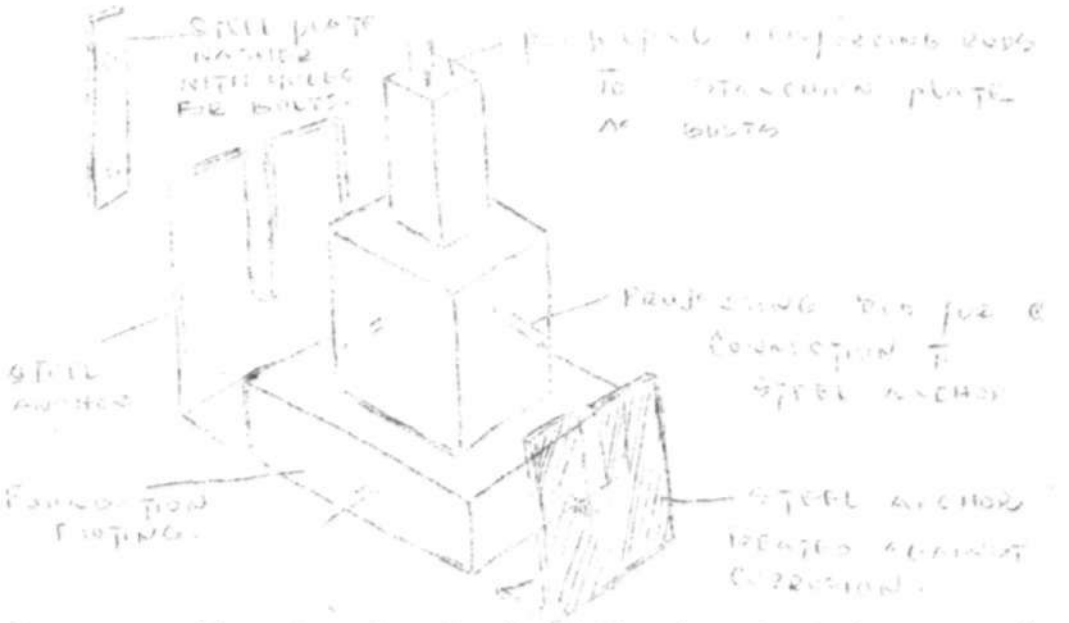
The pads are two types: that for averagely uniform terrain and that for non-uniform terrain.

These are basically the same excepting that that for the non-uniform terrain is bigger and heavier.

FIXING: To fix the foundation pad, a squzre hole is dug up to a size that can take the pads lateral side and an adult man's hand.

Cement mortar is firstly poured into the space to the required level and a prefabricated steel anchor (see list of prefabricated components) is placed at the four sides of the hole, well embedded into the mortar.

On hardening, the pad is either manually (if that for uniform terrain) or mechanically (for non-uniform terrain), placed into the hole and with knots, the foundation pad is tightly secured to the steel anchor by utilising the reinforcing rods projecting from the sides of the pad. The rods slot into a cut in the anchor.



In a non-uniform terrain, the foundation is raised, by means of bolted steel channels which are adjustible in height with an I-section as base. The channels also form an I-sedtion.

A steel channel is placed atop the channel I-section column to act as ties to other columns all of which are also tied together by bracing.

On this substructure frame work the superstructure is erected with the channel ties providing surfaces to which the floor slabs are placed.

In the case when my project is to have a permanent site, raft foundation will be adopted.

FLOORS.

In the case when my project is to be at a permanent site, as aforementioned, raft foundation will be used and this will serve as floor surface which will then be smoothened and covered directly with PVC tiles.

If my project is to follow the main idea on which it was conceived i.e. the mobility of the users, then the following is to be the floor situation:

Two types of concrete floor slabs are prefabricated - one which runs along the periphery of the structure and that which covers the inner areas. all of which are 60mm thick.and prefabricated in a 50 cm x 99.5 cm broad dimension.

The peripheral slabs have a 5 cm x 10 cm recess at one of the ends. These recess form column pockets where columns fit in during assembly.

The slabs are assembled with 1 cm tolerance space which also serve as expansion joints. These joints are filled up with any suitable realent and then the slab covered up with PVC tiles. after a damp proofing material has been placed.

The lower side of the slab bears directly on gravel or laterite hard core tamped into the earth at the initial pouring stage. The top of the hard core can be blinded by using sand or ash.

Generally my floor slab surface is always 100 mm above the finished floor to counter rain splashes penetrating the building.

FLOOR BEAM

This is of precast concrete. It is brought to and assembled on site.

It slots into the flange-web space of the I-section stanchion to which it is also bolted.

Directly on top of this bears the floor slabs which are botted to it.

WALLS

Due to the role of exclusion of radiation gain which the external wall panels are supposed to play, they are corrugated to the outside and plain to the inside. The partition panels are plain on both sides.

The panels are made of two sheets of asbestos to the external face and a sheet to the inside. The first external sheet is corrugated and glued to the inner sheet.

These sheets sandwich panels of wood fibre boards which are insulating materials. These together provide adequate counter to radiation gain. To the ends of the panels are timber studs which facilitate screwing to steel clips and then to the stanchion.

ROOFS:

A system of bolted light steel components consisting of two channels, and six angles are bolted together to form a flat topped roof trues.

To achieve a pitch for the roofing, a channel, to which another channel serving as purlin is bolted, is connected to the top chord of the truss using a specially designed steel component. (see details).

Aluminum sheets prefabricated in 1.2m x 2.2m size is used. This ensures adequate overlap of sheets.

Hooks connected to the purlins are used to keepthe roofing sheets in place.

A well insulated ceiling type manufactured by the General Metal Product under the production name of SECCOLEX 10-E is

adopted because of lightness and the aesthetics it affords the interior.

OPENINGS:

Doors: Flush doors are used for most of the doors except for main entrances to some functions which are of glass panels.

Doors should be utilised as they provide low level ventilation necessary in hotter areas and also they aid lighting.

Windows:

Adjustable louvrewindows are used for the following reasons:

(1) They are cheap

(2) It gives variable ventilation upto 100%. This suits the climatic requirements of the zones. for whilst the hot himid zone will need a completely open space, the hot arid zone will demand minimal openings.

ANCILLIARY COMPONENTS

Amongst these are the wall balancers, threshold components etc.

Balancer: a light steel angle specially designed to project over external wall panels covering their top, and dropping down to keep the walls in position.

The balancer is bolted to the lower end of the truss. These also serve as roof beam

Threshold: This is a special light steel component into which the wall panels fit and are bolted.

It is used to keep both the upper and lower end of partiiton walls in place It is bolted to the floor slab and also hooked to the turss.

CHAPTER 14

SERVICES

WATER SUPPLY:

Like is my intention to save cost with my project, a judicious use of waterwill also enhance the save in cost. In this view, less consuming water facilities used are:

- showers which use 50litres to the 150 litres used by baths
- Low level W.C. suites thes are though, not more economical than the high level WC suites water-worse but they are more aesthitical and less psychologically disturbing.
- Leakages of pipes must be discorugaed.

Watersource:

It is anticipated that wherever the project is sited, it will be close to municipally treated pipe borne water.

In the case when there is not pipeborne water available, water pumps are used in drawing water from any water source available, into a temporary treatment tank where it is treated by the addition of chemicals and using sendimentation system.

The treated water is then pumped to an overhead tank siting on steel stanchions from where the water is distributed to the site.

Run-offs from roofs are channeled away from the walls to discourage moisture encroachment. The run off in the courtyard facing facades are directed into the courtyard to help in creating greenery.

WASTE DISPOSAL

It is again supposed that wastes from theproject site will be connected to the municipal waste drainage when such a facility is not

more than 20m from the site periphery.

Septic tanks which is a very common way of sewage treatment, is most preferred.

The septic tanks in addition to serving as storage for effluent, also serve as the first stage of sewage treatment by breaking down solid matter by bacteriologic action.

The effluent from the septic tank should be discharged into a soakaway-pit at least 15m from the nearest building.

The sludge from the septic tanks should be removed periodically every 3 - 5 years and buried or composted.

CHAPTER 15

FIRE PROTECTION OF BUILDING

The matter of fire protection may be best considered by dealing separately with the effect of fire on the following.
First: on individual building materials, secondly, on composite building elements, thirdly, by regarding the structure as a whole (together with such aspects as means of escape from a burning building and access for firemen) and finally by the position of buildings relevant to each other.

A necessary preliminary to the study of fire protection is to understand how materials burn and why fire spread. Before a material can be ignited, the temperature of its surface must be so high that thermal decomposition occurs, accompanied by the evolution of combustible gases. If at this stage a sparkeor otherssimlar sources of heat ignite these gases, the material stats to burn. Subsequuntly, balance of heat is generated by the inital ingnition and that lost by conduction and radiation to surrounding materials

Building materils are generally subject to test for non-combustibility. In addition, this standard specifies a flame-spread test, an ignitability test and a fire propagation test for wall and ceiling linings.

THE SPREAD OF FIRE IN A BUILDING

It is not pradicable to build fireproof sturctures or entirely prevent the outbreak of fire. It is possible, however, to minimise the effect of fire by a wise choice of material and construction techniques and by planning aimed at limiting the growth of a fire

This can best be achieved by designing a building as a number of separte units, so that should a fire commence in one of them it will be contained in this unit long enoughto permit the escape of occupants, access by fire-fighting service and also mounting of savlvage operations in adjacent areas, should this be necessary.

Some of the factors which determine the necessary period of containment of a fire are the activities pursued in the building, the height of the structure, its proximity to other buildings, its accessibility for the mounting of fire fighting operations and the amount of combustible materials present in any unit of the building.

The contents of a building together with the structural elements are referred to as FIRE LOAD and this is defined as the joules that will be generated per square meter of floor area should a fire occur. The classification of fire loads has been broken down into three categories as follows:

a) Occupancies of low fire load : This category is satisfied if the fire load does not exceed an average of 1150 MJ/m^2 over the net floor area of any compartment, and an average of 2300 MJ/m^2 is permissible inlimited isolated areas. These conditions normally occur in domestic dwellings, offices, public buildings, hospitals and schools.

b) Occupancies of moderate fireload: This condition is satisfied if the average fire load exceeds 1150 MJ/m^2 but is less than an average of 2300 MJ/m^2 with a permissible average of 4600 MJ/m^2 on limited isolated areas. Such conditions are normally exist in most retail shops and most factories and workshops.

c) Occupancies of high fire load: This condition is met where an average of 2300 MJ/m^2 is exceeded but is less than an average of 4600 MJ/m^2 pver a met f‡ppr area. Isolated areas may have fir load average of 9200 MJ/m^2. These conditi ns are normally found in warehouses and other areas of bulk storage.

FIRE PROPERTIES OF MATERIALS

As aforementioned building materials undergo along with other test, the non-combustibility test. The classification of a few materials is given below:

Although materials for building should be non-combustible, it is unreasonable to insist upon this for all aterials, since that will impose harsh restrictions on design.

The standard indicates how these results should be processed in detail to classify the material for surface spread of flamme:

The classifications are as follows:

CLASS 1: Those faces on which not more than 165 mm flame spread occures;

CLASS 2: Those faces on which the spread of flame neither exceeds 215mm, dufing the first 1½ minutes test with heat source; nor exceeds a final value of 455 mm.

CLASS 3: Those faces on which the spread of flame neither exceeds 265 mm during the 1½ minutes test, nor exceeds 710mm at 10 minutes.

CLASS 4: Those faces on which the spread of flame neither exceeds 265 mm during the first 1½ minutes test nor exceeds 710 mm at 10 min.

RESULT OF COMBUSTIBILITY AND SURFACE SPREAD OFF FLAME TEST ON BUILDING MATERIALS

Materials	Combustibility	Spread of flame Classification
Asbestos cement	None	Class 1
Asbestos wallboard	"	1
Fiberboard	Combustible (duet paper)	1
Fibre insulating board and hardboard impregnated with ammonium phosphate	Combustible	1
Wood-wool slabs	Combustible	1
Timber impregnated with ammonium phosphate	"	4
Synthetic resin bonded laminates	"	2
Resin bonded chipboard	Combustible	2 or 3*
Hardboard	Combustible	3
Strawboard	"	3
Plywood and timber weighing more than 400 kg/m^3	"	3
Plywood and timber weighing less than 400kg/m^3	"	4
Fibre insulating board	Combustible	4

* according to composition and density

† Asbestos insulation board 25mm minumum thickness to provide 2 hr fire protection.

‡ Chlorinated rubber paint as counter to flame spread

Thermal movement of building materials (mm per metre for a change of 25°C).

CHAPTER 16

SITE PLANNING

To plan the layout of a site, ample considerations must be given to some factors which make a layout architecturally impressive and workable.

Among those factors are:

() Design considerations

b) Background of site

c) Climate

d) Sound and Noise

e) Topography

f) Expansion

g) Services

h) Architectural qualities

i) Landscaping

j) Architectural integration of functions.

BACKGROUND:

This project is intended to be sited in five different locations, Port Harcourt being one of them.

The site for the Port Harcourt project is the Bari Camp - an already acquired land by the Army.

The general land area is over twenty hectares with some already existing facilities like roads, water supply, electricity and manpower supply, that can be tapped for use in the project.

DESIGN CONSIDERATIONS:

Port Harcourt is in the hot humid climate and in designing for this type of climate major problems like humidity discomfort, glare etc must be solved. In solving the humidity problem achieving corss ventilation is the major line of countering. To this effect, the buildings are laid out with at least three times the height space between them to effectively provide cross ventilation.

In this area, rainfallis heavy almost all year round and adequate channeling of run-offs must be provided.

Roofs should slope sufficiently to provide run-off surfaces for ram water.

CLIMATE

Port Harcourt is in the hot humid climatic zone of Nigeria. The following are the characteristics of the climate type and their implications to design.

1) Over 2000 mm of rain. This keeps the water table high; in most places about 3.5 m to the surface. This implies considering piling when a structure goes higher than four stores.

2) S.W. Monsoon wind: This is the most prevalent wind in the area prevailing for twelve months. This is moisture laden and cool. It is desirable into a building to counter the enervating situation of humidity by aiding ventilation.

3) SEA BREEZE: This results from the difference is heat capacity of land and sea. Coming from the sea mostly in the night, it brings about some cooling effect and this should be channelled into a design.

b) HUMIDITY: Very high humidity exists in this area and an open layout is employed to help ensure corss-ventilation which is the only natural counter to humity discomfort.

Water bodies and pools are avoided as these increase vapour content of the area.

SOUND AND NOISE:

For the sake of conversational privacy, buildings are spaced at least 10m when their windows are open. This is also in line with the layout out requirements for cross ventilation.

Trees and foliages are used to dimnish high frequency sound resulting ffom schooling.

TOPOGRAPHY: Flat sites are most preferred for all my layouts as they pose fewer building problems though they may need special drainage provision.

In the case of Port Harcourt, my structures are laid out along the contours thereby facilitating the channelling of runoffs.

EXPANSION: All layouts should be done in a way to provide for future expansion. To ensure the success of the layout in the direction of expansion opportunities, a prototype layout pattern called the Hierarchical Prototype is used both in Port Harcourt site and in other sites (see organisational concept)

SERVICES: Buildings should be arranged to ensure that connections of services like water supply, sewage and electricity are short. For maintenance pruposes, these connections should be very accessible.

ARCHITECTURAL QUALITIES

The architectural qualities of a site embraces the following:

a) The scenic beauty it poses, by way of topographical appearance vegetation cover, natural occurances like water bodies etc.

b) The aesthetics of the surrounding environment.

c) The general nature of the site.

The site layout should be done in such a way as to take advantage of these qualities when possible.

LANDSCAPING

A well landscaped layout offers added beauty to a design.

In the hot humid climate, discourgaing solar radiation gain is one of the problems a designer encourters. Landscaping is one of the ways of achieving this goal.

In the hot arid climate solar radiation is the major design problem. Creation of volume by close layout with greens as courtyards is the best way of countering radiation gain.

Thus, a layout should be adequately landscaped with grasses, shrubs and trees.

CHAPTER 17

MATERIALS

In choosing my materials, the following were the major considerations

1) Cheapness

2) Ease of prefabrication and handling

3) Reuseability

4) Suitability of use in different climatic conditions.

ASBESTOS:

This material appeared to suit my purpose a lot as it is available in large quantity in the country it is basically an insulating material with low diffusivity, it is incombustible, easy to work etc.

STEEL:

This is obviously costlier than wood which is also suitable for use as frame-sturcture members. Steel however, is, if painted by aluminum paint and epikote - ter can stand use even in very salty waters. Also Nigeria intends in due course to be exporting steel which implies high availability of it.

TIMBER

This is an alternative to steel as a structural member. It is in abundant supply in the country and can well be treated to stand the mild effects of Nigerian climates.

Treated timber however, will deteriorate in a speedy manner in the climate of far north where excessive heat, dust effects etc are problems to structural materials as they cause the timber warp.

In the southern part of the country, dampness, fringal attacks and salt water.

ASBESTOS INSULATING BOARD

Use:	fire protections of structural steelwork, ceilings, walls, partitions etc.
Composition:	asbestos fibre, silica and hydrated lime.
Density:	500 - 900 kg/m^3
Appearance:	One face fairly smooth, reverse face slightly textured. Normal colour is grey-white. Available in natural and sanded surface finish
Combustibility:	Non combustible
Moisture content:	3.5 %
Water absorption:	100% by weight
Dimensional changes due to moisture:	0.15 - 0.20 mm per 1000 mm from normal to saturated state;
Effect of chemicals:	affected by acids but not necessary acidic fumes. Persistant to other materials lively to come in contact with it.
Effect of impurities:	None likely
Effect of micro-organisms:	Does not nourish mould growth. Immune to insect attack.
Thermal conductivity:	0.108 - 0.115 W/m^{oc}
Thermal expansion:	5×10^{-6} per ^{o}C up to $200^{o}C$. Slight contraction above $200^{o}C$.
Health hazard:	No effect when in use.
Durability:	Very durable when used internally.
Ease of working:	Can be cut and worked with ordinary wood-work tools.
Surface treatment:	Various decorative materials can be stuck on the board with appropriate adhesives.

Paint treatment: Sealing coat may be required prior to paint decoration.

Ease of cleaning: Natural surface is not easily cleaned.

ADVANTAGE OF LIGHT-WEIGHT PARTITIONS OR LININGS:

ADVANTAGES:

1) They can be accurately made in various sizes, eliminating much of site work.

ii) They can be erected without undue mess

iii) Being dry construction, it eliminates the problems of decoration associated with traditional wet construction.

iv) With some forms of core, such as foamed plastic, the thermal insulation afforded can be very much better than with traditional construction.

v) They can be readily removed or repositioned without causing serious damage to the remainder of the structure.

DISADVANTAGES:

i) Poor sound insulation

ii) Tendency to vibrate with heavy traffic etc and can be damaged by opening and closing of heavy doors supported by them.

iii) Cracking or opening at points between adjacent panels and at intersections caused by thermal and moisture movement can be difficult to camouflage.

iv) Some have poor fire resistance. Plaster boards are an exception to this.

v) Fixing attachments to these partitions can be effected with special devices but nevertheless this is often a disadvantage

compared with the traditional types of wall construction where screwing and nailing are relatively simple and effective operations.

What to Know

* Surface resistance to heat is higher material is of low emissivity.

* Surface conductance for rough surface is greater than for smooth surface becausd of ease of heat transfer in rough surface..

Problems of solar heat exclusion requres knowledge of the properties of building materials in relation to variable temp and heat flow. Annual variation of outdoor temp is of course of no importance in considering short term problem.

Daily variation is however, of considerable importance, particularly in relation to light structures but the most important problems are those concerning the exlcusion of sunshine.

The flow of heat is a single direction is governed mainly by thermal diffusivity. The larger the numercial value of diffusivity the more reapidly is a temperture change propagated through the material.

Insulating boards have diffusivity of 0.006 ft^2/hr and have a volumetric specific heat (loosely called thermal capacity) of 6.1.

SUNSHINE

This is the source of radiation the exclusion of which is the major design problem of my project.

Outside the atmosphere the solar intensity amounts to about 420 B Th U /ft^2/hr. The intensity recieved by structural element varies during the day and is a function of orientation.

a) Horizontal surfaces receive from 2-3 times more solar heat t than vertical ones.

b) Walls receiving maximum solar radiation are those exposed to East and West.

c) In walls facing North and South, latitude becomes an important factor in the complex problem of a building sited North of the Equator; a wall facing south correpsonds from the point of view of solar radiation, t a wall facing North in a building sited south of the Equator.

REFLECTION OF RADIATION

Reflectivity of a material determines the quantity of incident radiation which is reflected from the surface.

Materials selectively reflect radiations according to wave lengths which explains why light waves are readily reflected from light-coloured surfaces and are absorbed by dar ones.
Thus in choosing my materials I am assuming that they are capable of reflecting the troublesome of radiation.

The following points should be always remembered in the thermal designs of buildings:

- The effect of thickness and thermal properties upon the extreme temperatures and upon time-lag, which would help in the selection of walls for uncooled enclosures to provide maximum confort during the time of occupancy.

- The choice of thermal properties and thickness of the wall matefial was shown to be intimately associated with orientation and time of use.

- Buildings with all walls of the same material in a uniform thickness do not meet the ideal thermal requirements.

CHAPTER 18

FUNDING AND GOVERNMENT POLICY

FUNDING:

This project is intended to be funded by the Ministry of Defence. The defence budget of the country is most times very impressive and quite a sum goes to housing.

Since I intend to save cost from hotel accomodation, this amount will be supplemented by some fund drawn from capital expenditure of the previous fiscal year, to construct the project.

GOVERNMENT POLICY

The policy of the government on the military can be summed up from the following excerpt from a speech of the president to the nation inan end of fiscal year message:

"with regards to the Defence and Security of this nation, I want to re-iterate that our determination to build a mobile and virile military force will continue."

" ..... our efforts to provide accomodation will be intensified. Infrastructural facilites will be provided to those army barracks already completed in 57 locations".

- culled from Federal Government Budget in brief 1982.

Also in another speech on the 4th Development plan 1981 - 85, the president said:

"allocation of ₦1,200 million has been made for the programmes of the Nigerian Army .... Some of the major projects include the provision of barracks accommodation for all infantry divisions ...."

- culled from Outline of 4th National Development Plan. 1981 - 85.

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2 EXCERPTS FROM A REF BOOK ON CLIMATIC CHARACTER (HOT ARID)

(Table 1) (2): prepared by Building research Station, Watford.
Characteristics of hot climates: from the stand point of their effect on building design.
hot dry

	Desert or semi desert	Maritime desert
Temperature: Daily range (average).	20 F or more may exceed 40 F	10 - 15 F
day-time air temperature (mean max. d.b. in shade)	up to 100 F, or more	up to about 100 F, but in cooler season may be 70 - 75 F
Night-time air temperature or (mean min. d.b. in shade)	Usually above skin temperature of human body. Warmer period:70 - 75 F, cooler period: 50 - 65 F.	
Annual range	20 - 30 F. At tropics may exceed 30 F	15 - 25 F
Sky temperature	Depends on dust in sky; when clear below air temperature.	
Humidity	7½ - 15 mb, in rainy seasons up to 20 mb	15 - 25 mb
Vapour pressure; absolute humidity relative humidity	10 - 55 %	50 - 90 %
Rainfall Annual rainfall	Slight and variable; less than 10"	
Other characteristics of rainfall	Flash storms, in which up to 2" may fall, occur occasionally.	
Sky conditions: General appearance	Vapour in sky may be replaced by dust, then sky, particularly, towards horizon, bright (1,000 - 1,500 lamberts or more). In sandstorms, sky darkened by dust (250 lamberts or less).	As desert sky, but likely to be more cloudy.
Ground conditions: general appearance	Little vegetation: ground and rocks, brown or red. Close to sea, white glare from salt pans.	
Soil mosture	Ground very dry. Dries rapidly after any rain. Watertable deep or non-existent. On coast groundwater likely to be brackish.	
Air movement	Wind usually hot or warm, risk of whirlwinds or tornadoes, stiller at night than in daytime.	May be affected by monsoon winds; also by local on-off shore day-night wind pattern.
Other characteristics	High sun temperature and rapid cooling at night may cause materials to crack and break up.	Risk of corrosion due to saltladen atmosphere; also danger due to salts rising from ground

(2) This table is tentative. It is based on the characteristics of climates which are considered to set the building designer more or less similar problems. Local climatic data should always be studied. Upland climates are ommited in this table.

The first line of heat control lies at the surface (8). Since the surface temperature of sunlit material will be higher than that of the air, air movements over an exposed surface will reduce the external heat impact, and are particularly beneficial under hot conditions. The exchange effect can be increased by diluting the radiation over a large area by means of curved surfaces such as vaults and domes, or corrugated uneven surfaces (such as alternative recessed brick layers) which will also simultanously increase the rate of convection transfer. The determination of heat quantities entering a building is governed in large by the heat transmission of the enclosing walls, roofs, and other exposed parts of the building. Heat is transmitted by conduction, convection and radiation

The "coefficient" of thermal transmission (9) is designated by the symbol (U), which expresses the rate of heat transfer. It has been determined that heat transfer is retarded by the following elements comprising a wall, roof or other building section, taken in order from outside air to inside air.

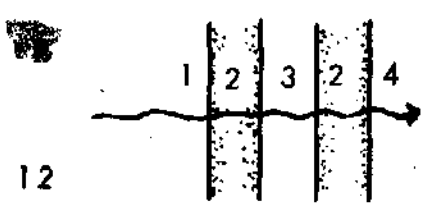
1. The resistance of a film of air on the outside (which is generally considered exposed to wind velocities averaging 15 m.p.h.)

2. The resistance of each layer of building material forming the structure section.

3. The resistance of each measurable enclosed air space formed within the building section.

4. The resistance of the surface film of air on the inner face (which is considered to be still air)

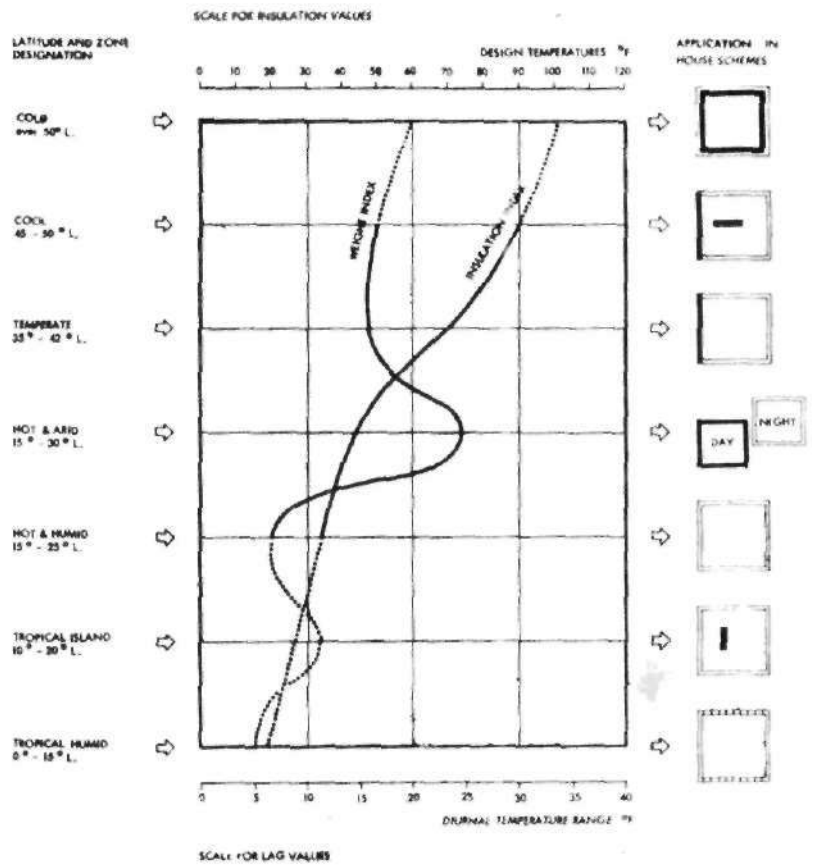
The overall coefficient of heat transmission (U) is the reciprocal of the sum of the foregoing resistances.



MULTI-LAYER WALL PANEL
EFFECTIVE IN HEAT CONTROL

(8) Victor Olgyay, "Design with Climate", Princeton N.J. 1963

(9) [illegible] Standards", the overall coefficient of heat transmission (U) is the amount of heat expressed in B.Th.U. [illegible] one hour per / square foot of wall, floor, or ceiling.



42. Regional importance of time-lag and insulation values (graph developed by V. Olgyay, shows the relation between the insulation values for different climatic regions and weight of building, and its application in house schemes in different climatic regions.



43. El Qued - Algeria.

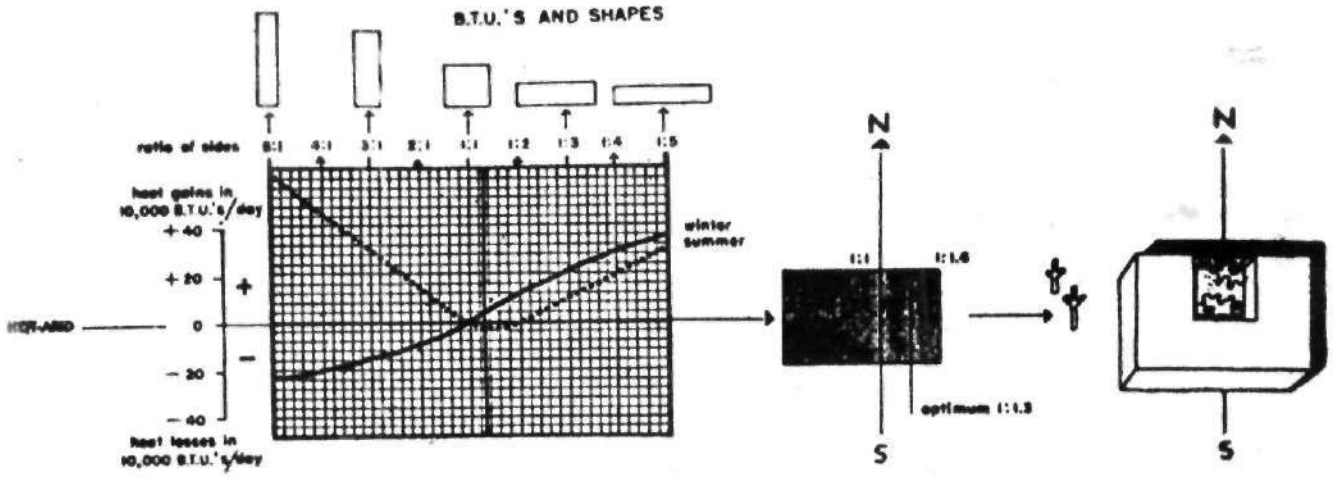
'From the above the following observations can be drawn:

1 - The square house is not the optimum form for location.

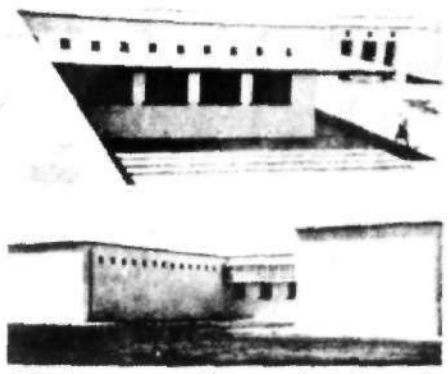
2 - All shapes elongated on the North-South axis were both in winter and summer with less etficiency than the square one.

3 - The optimum lies in every case in a form elongated somewhere along the East-West direction.

'A graphical presentation of the calculations is shown in (Fig. 48). On the graph the heat amounts received by different building shapes are charted. The numerical values of the heat amount received by the square house both in winter and summer were considered as starting reference points, and therefore located on the zero-line. The heat amounts received by other forms (see top) are charted from this line relative to it. The middle column illustrates the optimum and elasticity basic froms compared to the square area. At the right are architectural interpretations of the basic forms.'



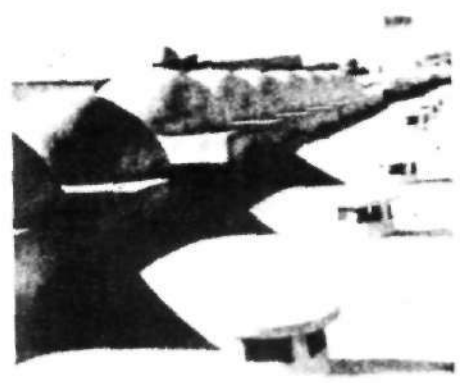
48. Basic form and building shape in hot arid climates.



101. Dispensary of Bizerte, P. Lallemand & M. Faure, architects.

Windward openings should be located high up and should be non-glazed apertues which can be covered with solid panels during the hot hours of day. This solution accentuates the complete separation between the function of ventilation and that of illumination. The glazed panels could be fixed, and it is preferable to give the ventilation inlets the form of slits along the facade as shown in (Fig. 101).

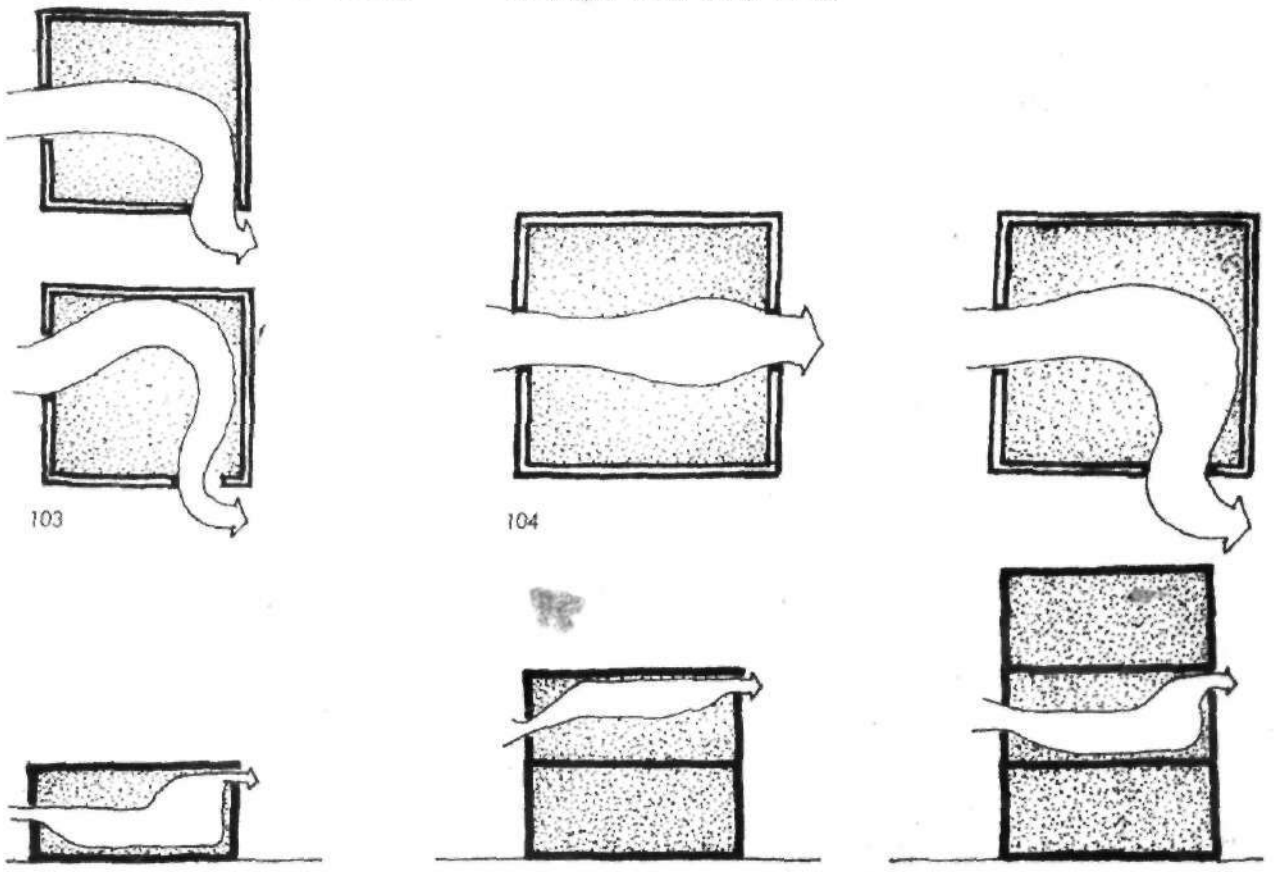
The point of air intake may be on the roof, partly to obtain cooler air and partly because the chimney effect operates in reverse under these circumstances: air flowing downwards inside the building and out at floor level.



102. Ventilation of vaults in Tunisia.

In multi-storey buildings the staircase well could be used as a chimney. It has been said that it is desirable to have air flow in the living zone of a building for the best summer cooling results. Therefore we should consider the effect of the geometry of our buildings on the air flow patterns within them (two main factors which determine the air pattern are location and types of inlets).

Experiments (48) show that when the opening is not located symmetrically the pressure on the sides of opening are unequal, causing the air to enter the room diagonally. Application of this simple but significant principle is depicted in (Figs. 103, 104, 105).



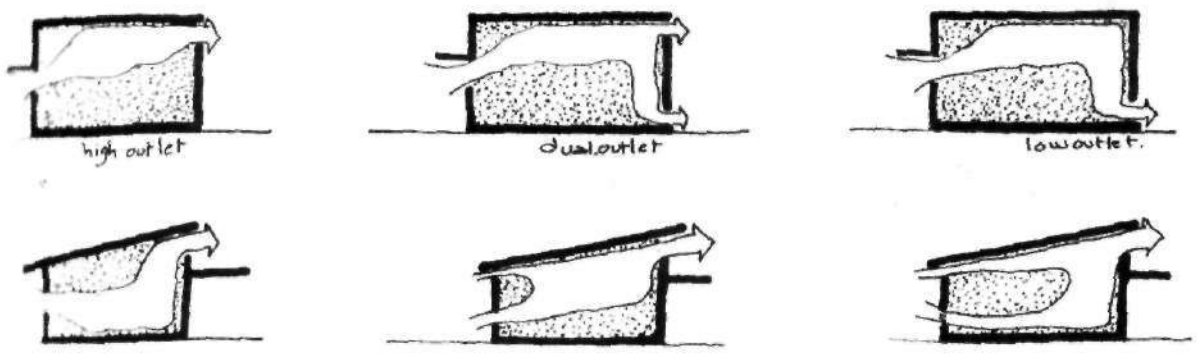
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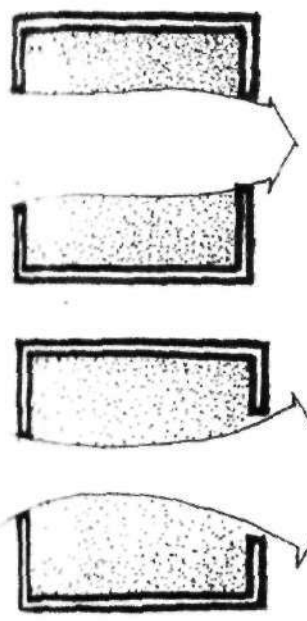
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(48) Robert H. Reed (Texas Engineering Experiment Station), BRAB Conference, Report No. 5.

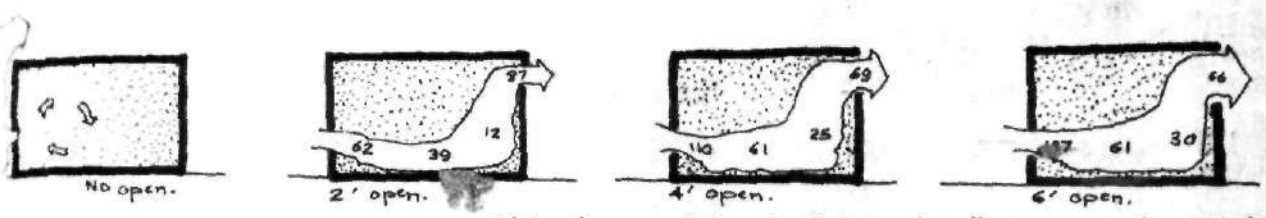
Location of outlets
(Figs. 106, 107) show the effect of certain outlet, inlet variations on the air flow pattern through a particular room. This should emphasize the fact that any architectural variation may have an effect on air flow, making it difficult to predict without testing.



Size of inlet vs size of outlet
One popular misconception about the proper sizing of openings is the practice of putting extremely large openings towards the breeze with the idea of "scooping" the air into the room, along with a strip of small opening on the opposite side of the room to allow for cross ventilation.
Actually the reverse situation would be better from the standpoint of summer cooling because maximum air speed within a building is acquired when the outlet is larger than the inlet, as shown in (Fig. 108).



(Fig. 109) shows recorded air speed tests conducted in a wind tunnel to emphasize the importance of size of the outlet. In these tests the outside uninterrupted wind speed is defined as 100 and the inside air speeds are expressed in %ages of the outside speed. The diagrams clearly indicate a substantial gain in the inside air speeds, as the size of the outlet is increased while holding the inlet size constant,



until in the case of a six-foot outlet (last one to the right) the air speed just inside the inlet opening reaches 127% of the outside wind speed.

Table 25. Percentage increase in volume of airflow inside a room with increase of outlet size.

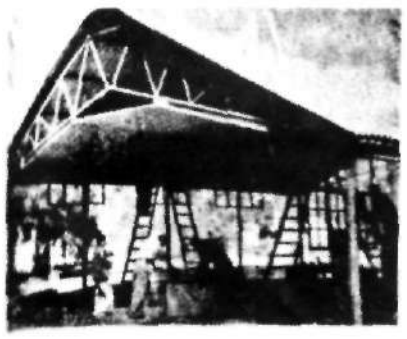
Inlet size	Outlet size	Wind direction					
		0°	15°	30°	45°	60°	75°
2′	2′	100	100	100	100	100	100
2′	3′	108	110	110	110	107	106
2′	4′	110	112	115	115	114	112
2′	6′	120	121	119	119	118	118

Table 27 (56) shows the average heat flux entering a construction through its roof, for some different types of light roof constructions, with ventilated and non-ventilated air space, for clear sky conditions.

No.	Nature of roof and ceiling	average heat flux from 9 a.m. to 9 p.m. (Kilocal./m2/hour)	
		non vent. top	vent. top
1	Aluminium Roofing asbestos-cement ceiling	26	26
2	Aluminium Roofing - ceiling of Isorel insulation, 12 mm	21	15
3	Aluminium Roofing - 4.5 cm glass-wool on asbestos-cement ceiling	14	7.5
4	Asbestos-cement roofing - ceiling of Isorel insulation, 12 mm	76	64
	Asbestos-cement roofing - ceiling of Isorel insulation, 12 mm	42	31
5	Asbestos-cement roofing - 4.5 cm glass-wool on asbestos-cement ceiling	22	14.5

The ventilation of the air space between roof and ceiling is not beneficial unless the ceiling is insulating or treated with insulating material on its surface, which makes roofs No. 1, 4 and 5 totally unacceptable in hot dry climates. With a roof of a galvanized iron sheet (presumed to be oxidized), the penetration-resistance to a flux of heat would be 15 % to that of asbestos-cement.

This leads us to a relatively detailed examination of construction and behaviour of some types of light roof construction.



169. The "Acron" tropical roof. The open space between ceiling and roof covering is very useful as breeze throughway.

(56) Dreyfus, op. cit.

Technological aspects of reducing ceiling height

1 - Window height can be increased up to ceiling level, with the corresponding effect on the interior space and facade. Increased window height improves air circulation and facilitates the removal of hot air below the ceiling.

2 - With overhanging roofs, a larger wall area is shaded.

3 - In multi-storey buildings the length and area of the staircase are reduced, with consequent simplification of the plan as a whole. In addition, the staircase can sometimes be laid out in a single flight of 15 steps.

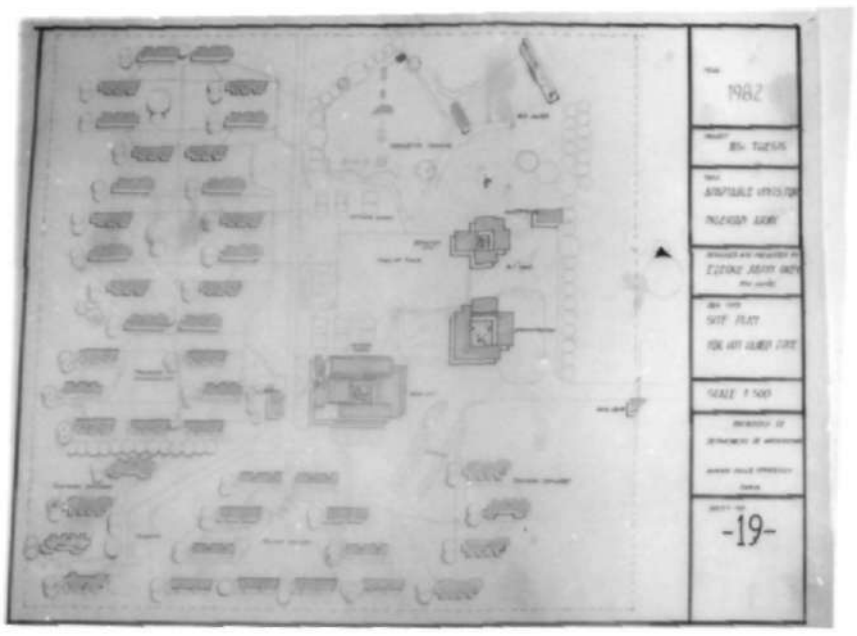
4 - A low ceiling gives an appearance of greater spaciousness; it is thus preferable from the point of view of proportion and creates comfort in contrast with the disagreeable sensation experienced in a small high-ceilinged room.

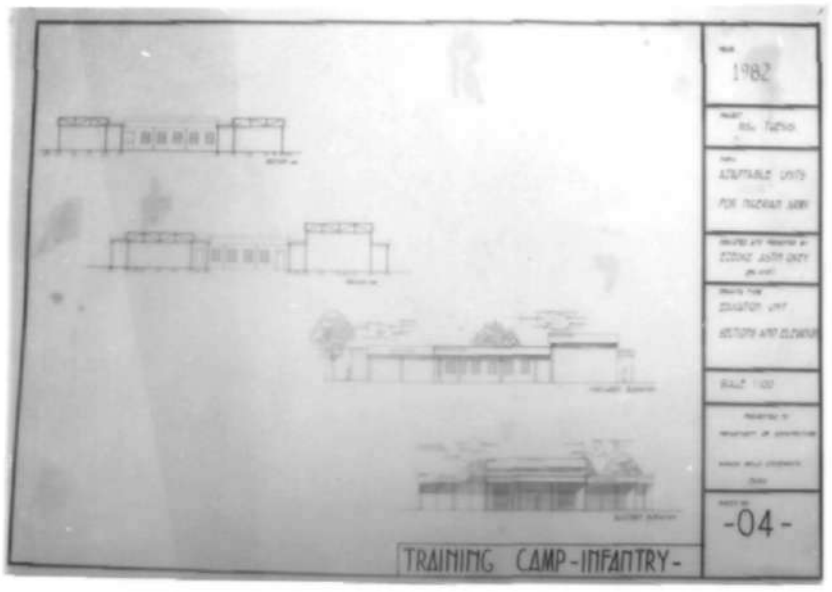
5 - In multi-storey buildings, the number of storeys can be increased, without affecting ventilation and without necessitating changes in block spacing (hence the possibility of reduced site development and landcosts per dwelling unit.)

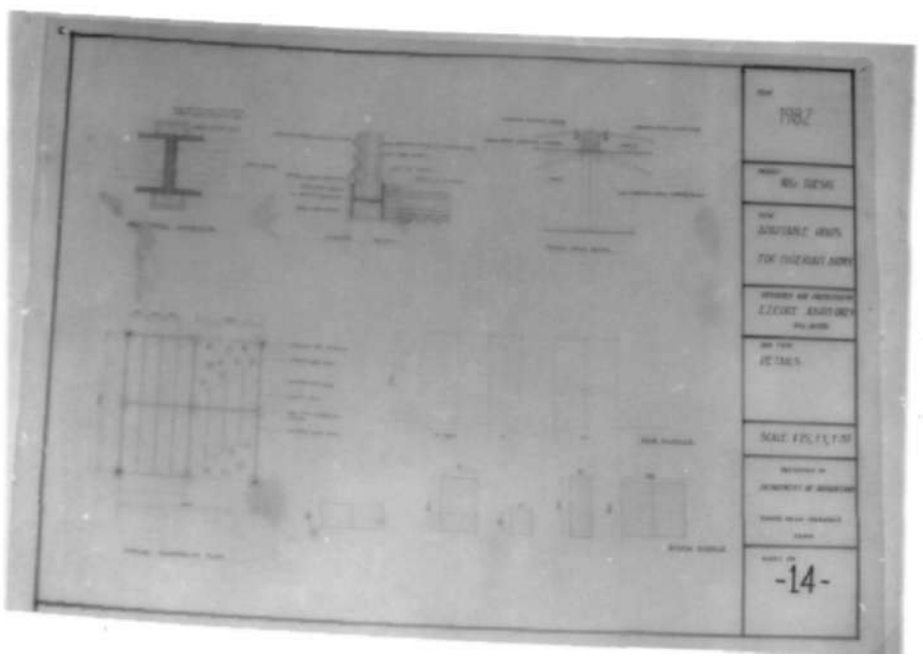
A series of temperature readings were taken in five two-storey buildings (two flat roofs and three pitched roofs, ceiling heights 2.32 to 2.86 meters) during a period from July to March. The ground-floor flats or 2.32 and 2.5 meters were cooler than the higher flats, and temperatures were unaffected by the type of roof. (Fig. 125). Upper-floor measurements showed once more the distinctive influence of the colour of the roof on indoor climate, (Fig. 127), and in the case of pitched roofs ventilation showed an additional effect, (Fig. 127)

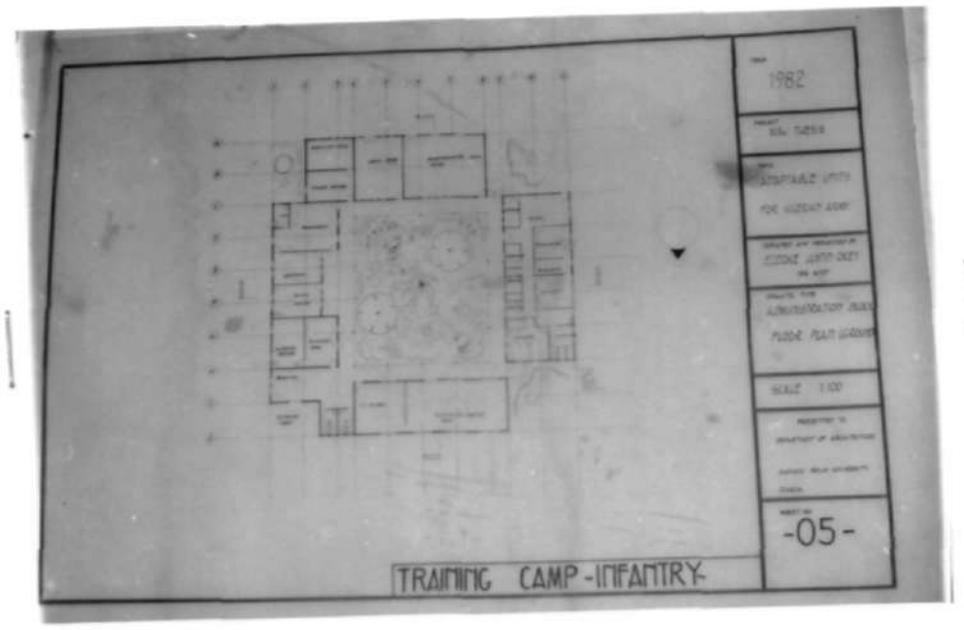
With whitewashed flat roofs, temperature differences up to 0.5 C (1°F) were absorbed between rooms with low and high ceilings, differences mostly in favour of the low ceilings, (Fig. 126. With pitched roofs of red cement tiles, the high rooms were slightly cooler (Fig. 123) with similar temperature differences of no physiological significance. With ventilated pitched roofs, temperature differences were even smaller and were mainly observed at night. It is concluded that for the particular climatic* conditions and on the basis of statistical analysis and architectural considerations the low ceiling height of 2.50 m is not inferior, for indoor comfort, to the customary height, and is actually preferable from the standpoint of interior space design.

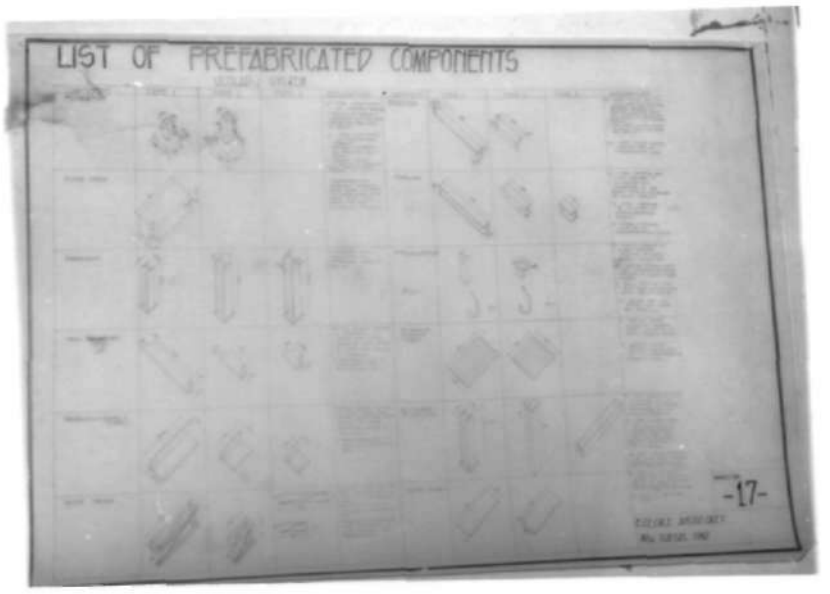
* Hot dry climate.

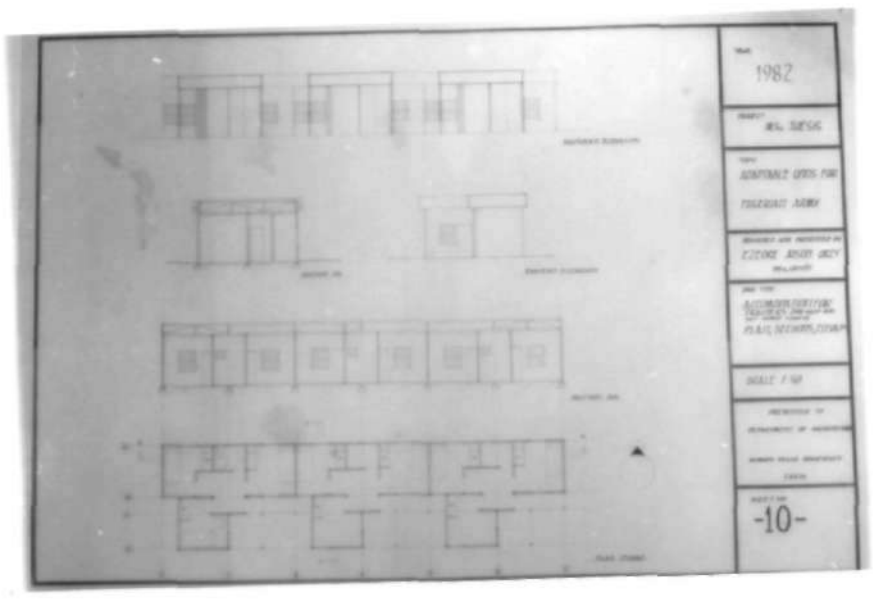

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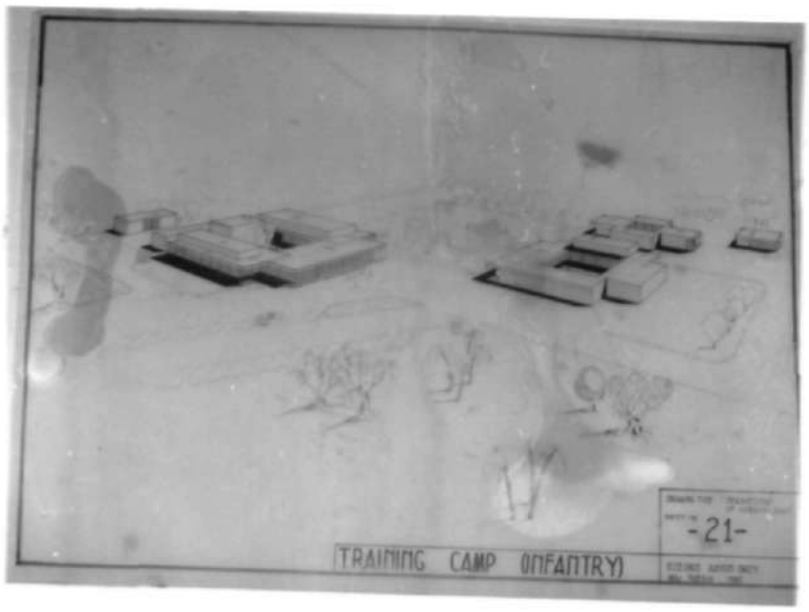

1982
TRAINING CAMP-INFANTRY-
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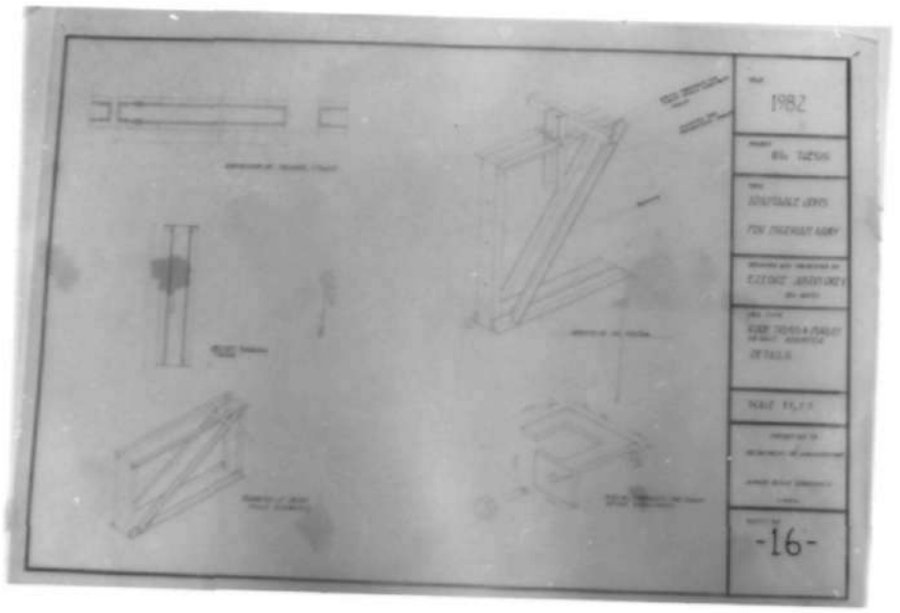

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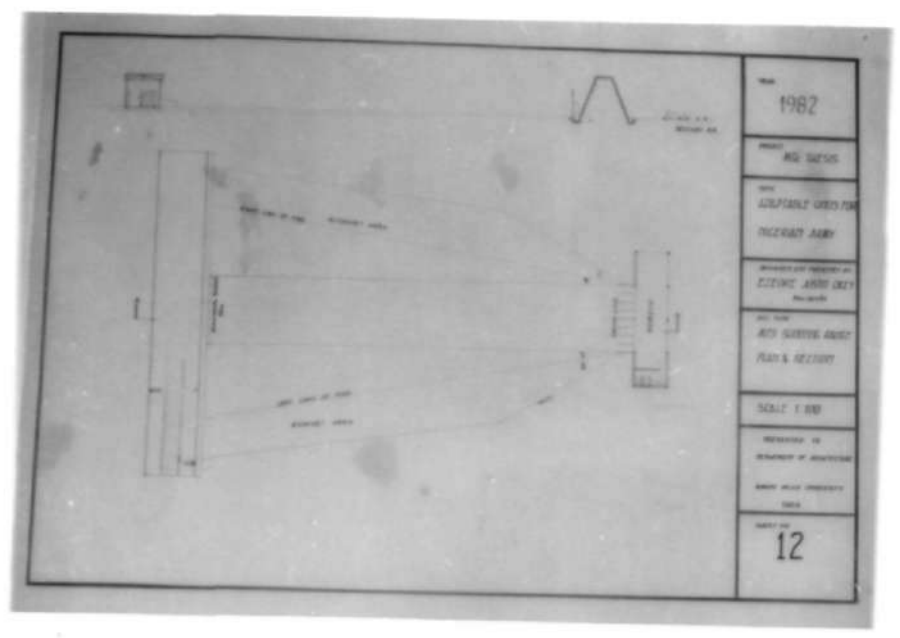

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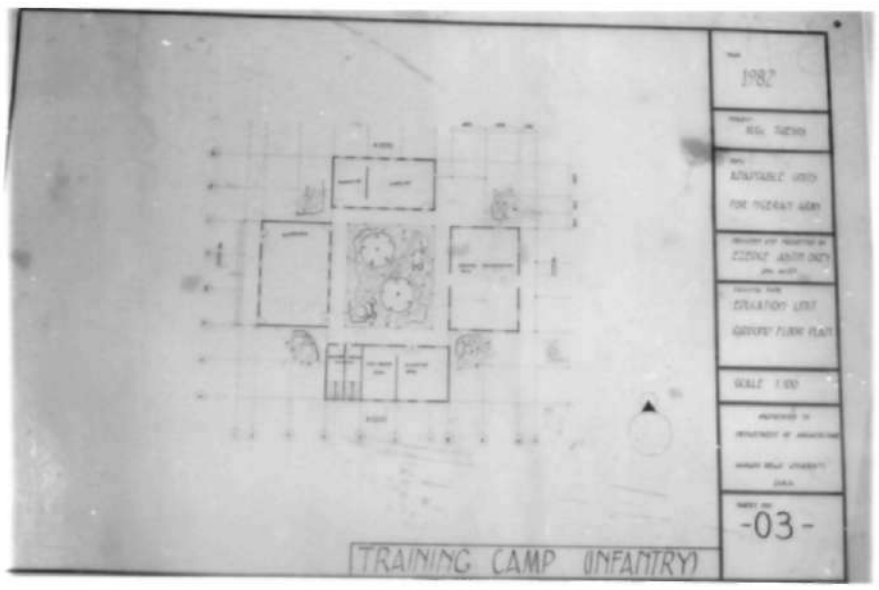

LIST OF PREFABRICATED COMPONENTS
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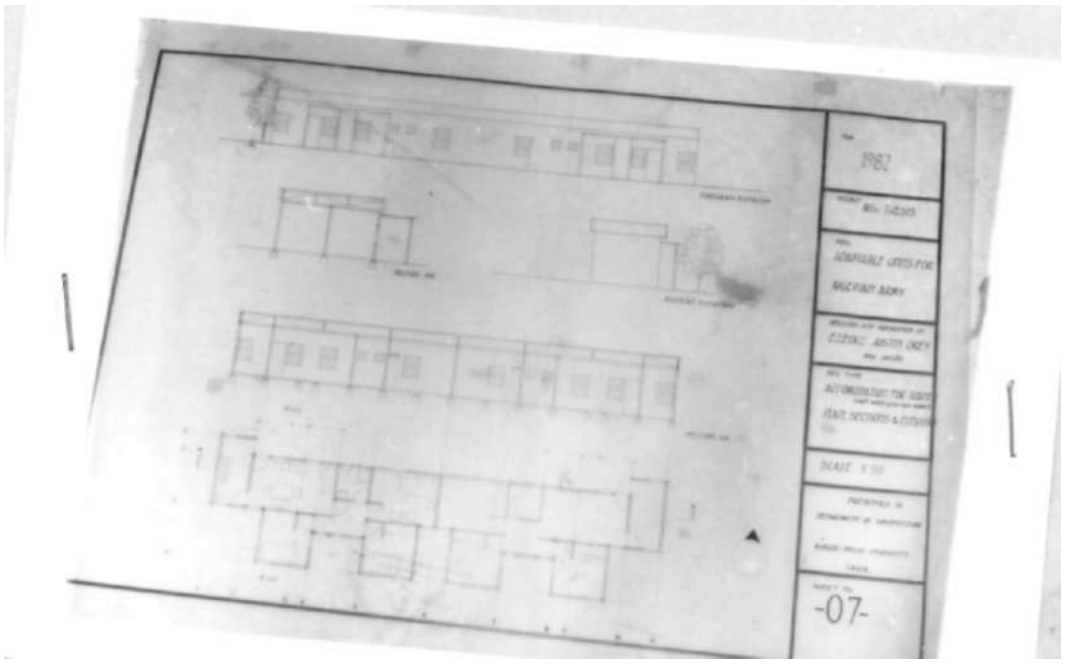

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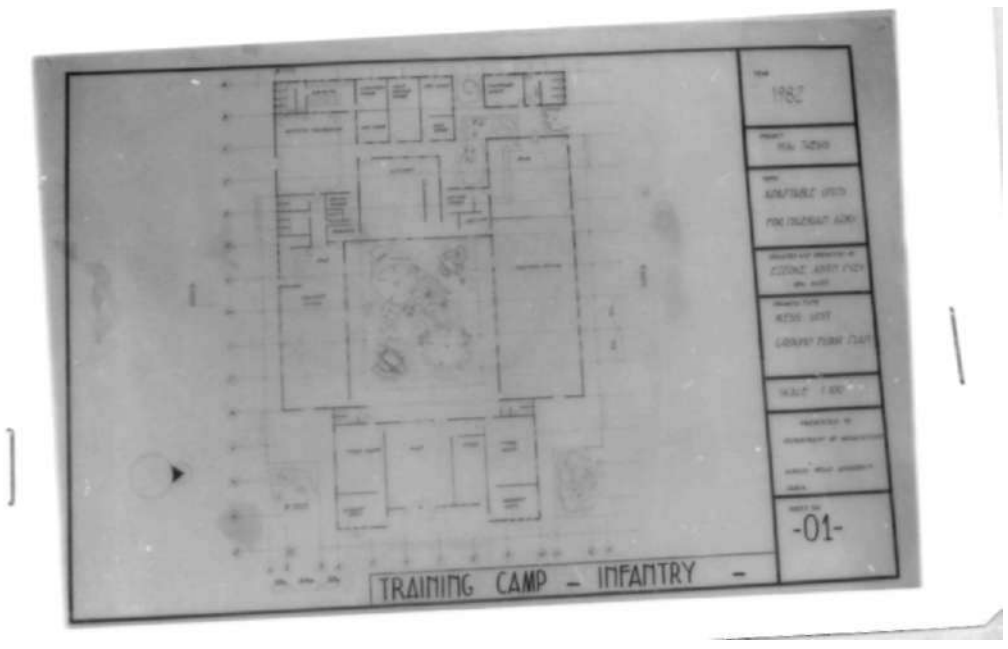

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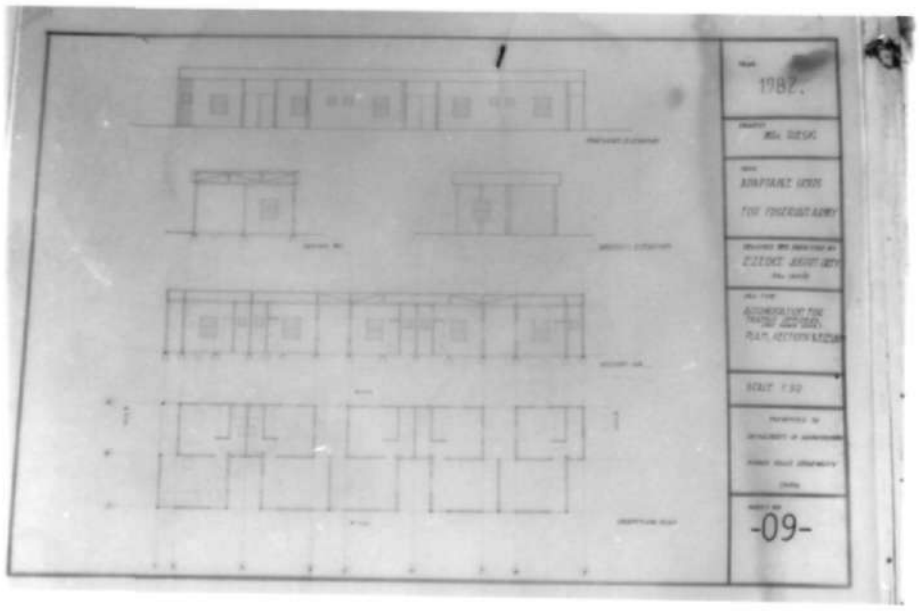

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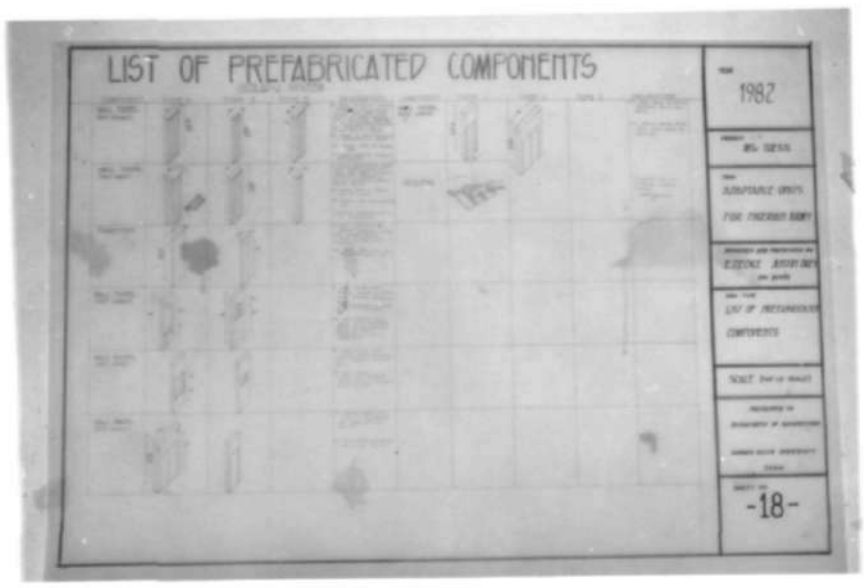

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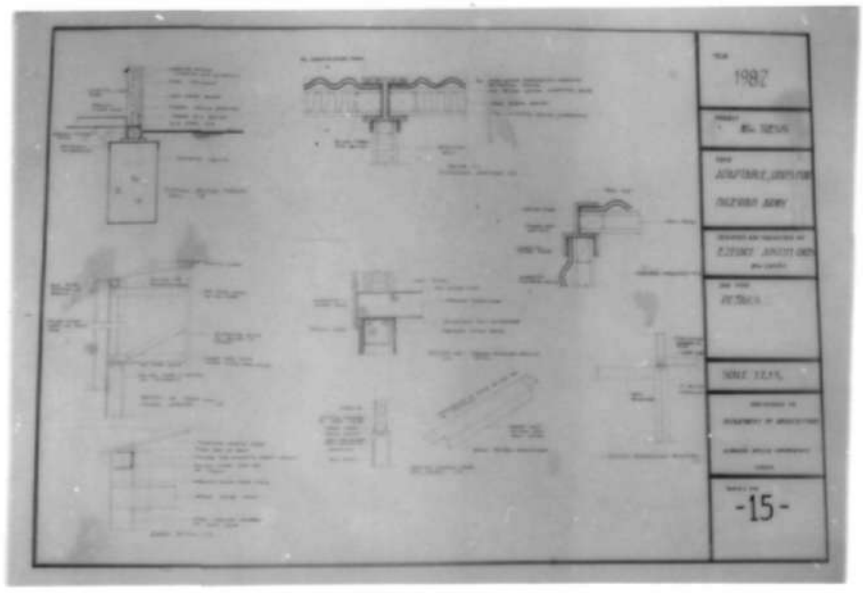

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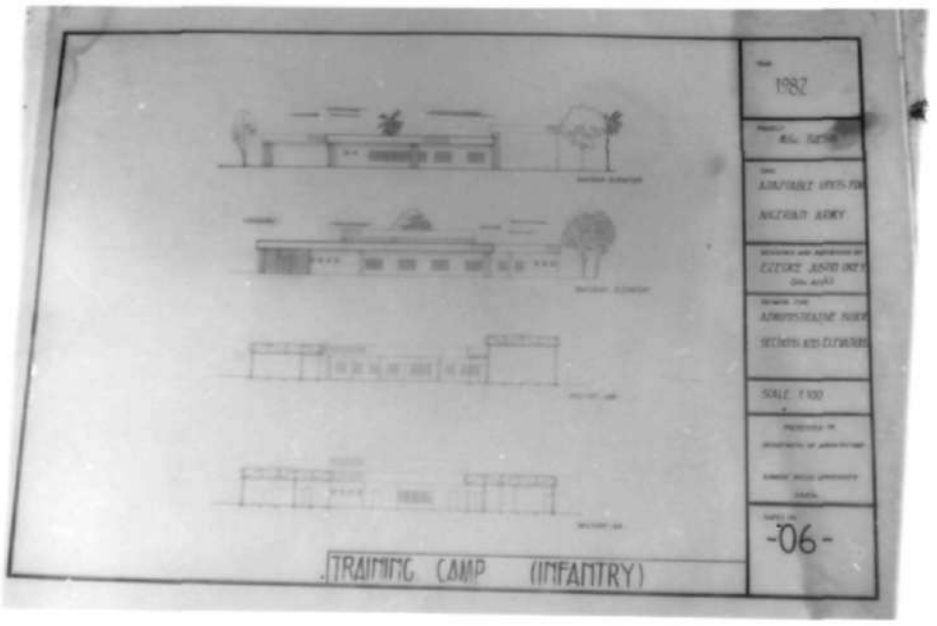

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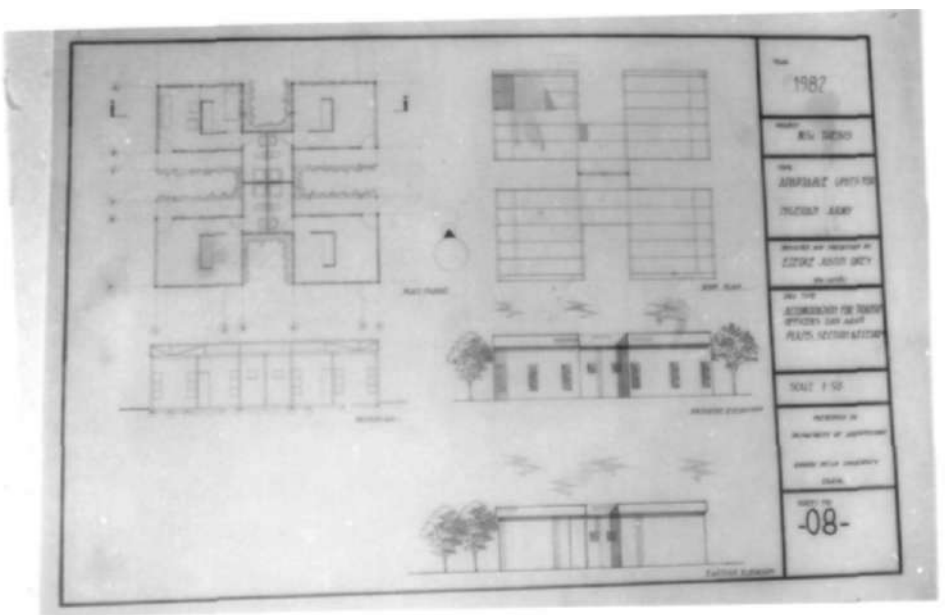

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TRAINING CAMP - INFANTRY -

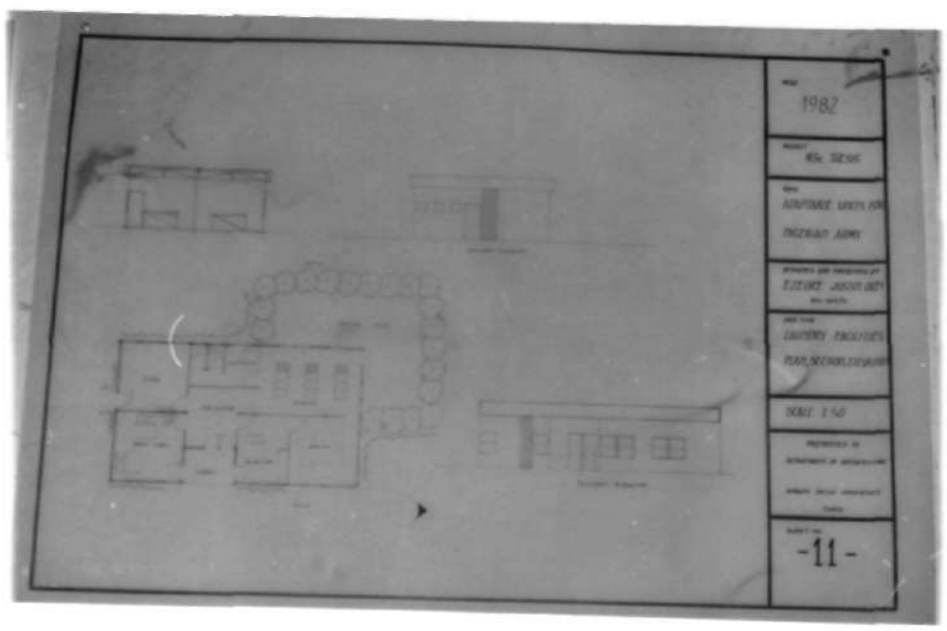

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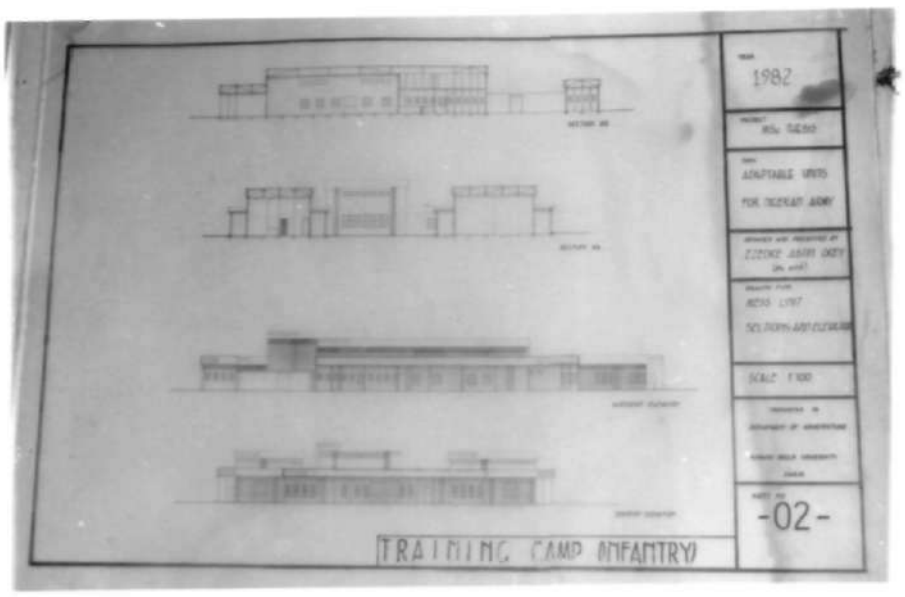

LIST OF PREFABRICATED COMPONENTS
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-18-

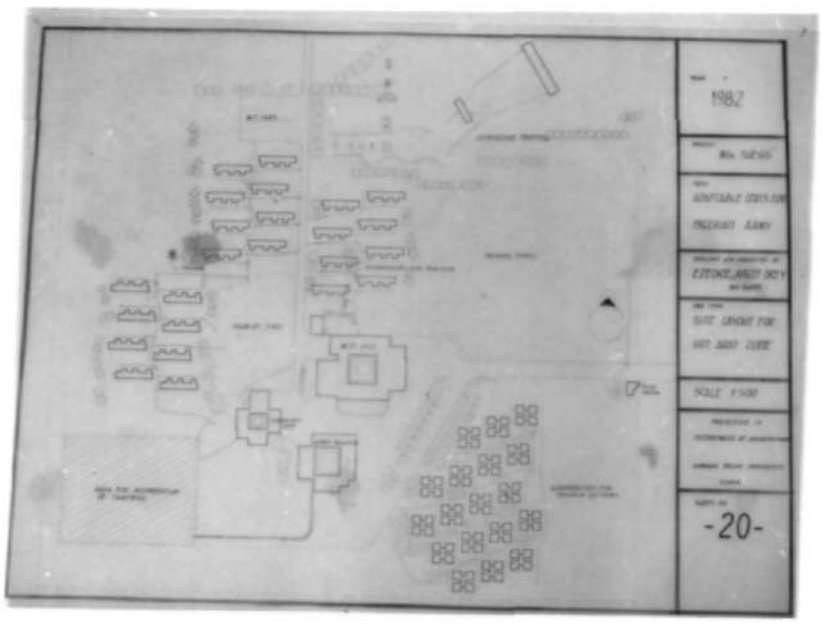

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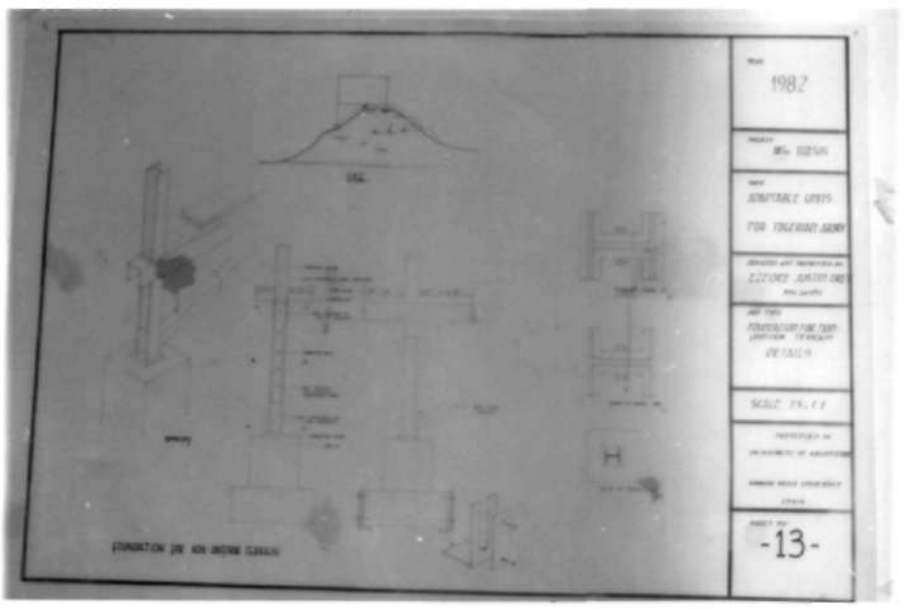

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TRAINING CAMP (INFANTRY)


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1982
ADAPTABLE UNITS
FOR FEDERAL ARMY
SCALE 1:100
-02-
TRAINING CAMP INFANTRY


1982
SCALE 1:500
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1982
ADAPTABLE UNITS
FOR FEDERAL ARMY
-13-