# NEW TERMINAL BUILDING
# KANO INTERNATIONAL
# AIRPORT KANO

By

ABBA, ALHAJI ALI

(JUNE, 1983)

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A Thesis submitted to the Post-graduate School, Ahmadu Bello University, Zaria in partial fulfilment of the requirements for the degree of Master of Science (Architecture) Pepartment of Architecture, Faculty of Environmental Design, Ahmadu Bello University, Zaria, June 1983.

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## D E C L A R A T I O N

I Abba, Alhaji Ali declare that this thesis has been written by my person and it is a record of my research work. It has not been accepted in any previous application for a higher degree. All quotations are distinguished by quotation marks and the sources of information are specifically aknow aknowledged by means of references.

Alhaji Abba

ABBA, A. A.

6/6/83

# DEDICATION

This work is dedicated to the following:

ALLAH - for giving us so much beauty and poetry to contemplate upon.

MY LATE FATHER - for foresight.

MY MOTHER - for all the patience during the odd months at Dala Orthopaedic Hospital, Kano.

MY BROTHERS AND SISTERS - for being who you are.

## A C K N O W L E D G E M E N T

I wish to make my sincere and deep appreciations to the following (alphabetically):-

Abba-Gana, M. - for being a wonderful brother.

Airport Engineer, Kano
Airport Manager, Kano } for help in the data collection.

Airport P.R.O., Alh. M.A. Clibok - for the brotherly help.

Ali, Tamadi & Family - for all those years

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John C. S. Mr & Mrs. - for their keen interest

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Yerwa G. S. S. Maiduguri - class of 1970 - 75 - for "The World According to Us".

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Chpater One

## 1.00 INTRODUCTION

The desi gn for a new terminal building for the Inteinational Airport at Kano is envisaged in the current development plan. As a first step additional land adjacent to the present site has been acquired and compensations paid to the affected owners. The firm of N.A.C.O. (Netherlands Airports Consultants) have been commissioned to carry out the master planning effort. The master plan has been completed and accepted by the N.A.A. (Nigerian Airports Authority).

The N.A.C.O. Master Plan is the basis for this design for the terminal complex. The Master Plan was used as a guide line only; it was not allowed to preclude important innovations in the development of the detailed plans.

### 1.10 The Context of the Problem:

In the last ten years Nigeria has experienced tremendous national wealth from crude oil revences, the present temporary glut not withstanding. With this increase in national wealth, there was recorded a corresponding rise in the national disposable income; which has, coupled with increased work free days, created a taxing demand on the air travel industry. This is attested by the increase in thefrequency of flights, introduuction of bigger wide-bodied aircrafts and the concerted governmental effeorts of expanding and up-dating the existing airports in the country.

The Kano Airport isthe second busiest and the attenative gateway into Nigeria. About sixty percent of the hadj airlift takes place at the Kano airport. It also serves as a gateway to the overseas for ten of Nigeria's nineteen states.

The peak hour problem at Kano airport is baffling. This has resulted in compromising passenger comfort, proccessing time, operational efficiency and a general state of confusion between baggage handling and passenger handling. This situation is farther compounded during the summer vacation, Hadj period and the harmattan season, when the problems of over booking and bad weather ensue.

1.20 Brief History of Kano Airport:

The window to the aviation world was opened in 1936 (forty seven years ago) for Nigeria, when the first aircraft to land in Nigeria - an Imperial Airways twin-engined de-Havilland DH-86 - was heralded with a great deal of pomp and pageantry by the Emir of Kano with his escorts. Two men on camel back blowing long trumphets were also there to herald this threshold in aviation history for Nigeria. To this day the tradition of heralding the landing of an aircraft by a trumphater obtains.

Chapter Two

## AIMS AND OBJECTIVES

2.00 The aim of this thesis is to design a new terminal building for Kano International Airport with the objective of providing an effecient passenger processing machine.

The development of the terminal area plan and plans for the components within the terminal are will evolve from demand/ capacity analysis, the runway configuration, land-use criteria established in the airport lay-out and land use plans.

By definition a terminal building is "an area use or interded to be used for such facilities as terminal and cargo buildings, gates, hangars, shops and other service buildings; automobile parking, airport hotels and restaurants and garages and vehicle service facilities used in connection with the airport.

The degree of which terminal area plans are developed under Master Plan efforts are limited to concept studies and conceptual drawings. This usually includes the dimensioning of overall areas on layout plans and developement of schematic drawings adequate for delineating basic flows of passengers, baggage cargo and vehicles. This includes movement from car parking areas or curb space to aircraft and back again. The development of details which are requred in construction drawings and specifecations should not be included in the airport master plan. It should also be kept in mind that concept drawings should not be so definitive as to preclude airportant changes which will evolve with the development of detailed plans. Such changes are mevitable as an airport project moves through final design and construction.

The objectives of the terminal area plan should be to achieve an acceptable and practical balance between passenger convenience, operating officiency, facility investment and above all aesthetics. The objective of good aesthetics is to humanise the inhuman aspect of a machine that processes passengers from land transportation mode to air-transportation mode and alleviate attendant anxities associated with flying. Thus, the psychological comfort characteristics of the terminal area should afford the passanger orderly and convenient progress from his automobile or public transportation through the terminal building to the aircraft and back again. One of the most important factors affecting the air traveller is walking distance. It begins when the passenger leaves his ground transportation vehicle and continues on to the ticket lobby, and to the point he boards the aircraft. Therefore, a prime objective in the development of a terminal area plan should be to minimize the walking distance by developing convenients auto parking facilities, convenient movement of passengers through the terminal complex, with convegances which will permit fast, and efficient handling of baggage. The planner should establish objectives for average walking distances from terninal points to parked aircraft convegances for passengers such as escalators, moving walk-ways, and baggage handling system is to be considered. The functional arrangement of the terminal area complex with its aircraft maneuveing spaces should be flexible enough to meet the operating characteristics of the airline industry for handling passengers efficiently and for fast ground servicing time for aircraft so as to achieve a minimum gate occupancy time and maximum airline

operating economy. The final objective should be to develop a terminal area complex which provides all necessary services within an optimum expenditure of funds from the standpoints of capital investanent and maintenance and operating costs.

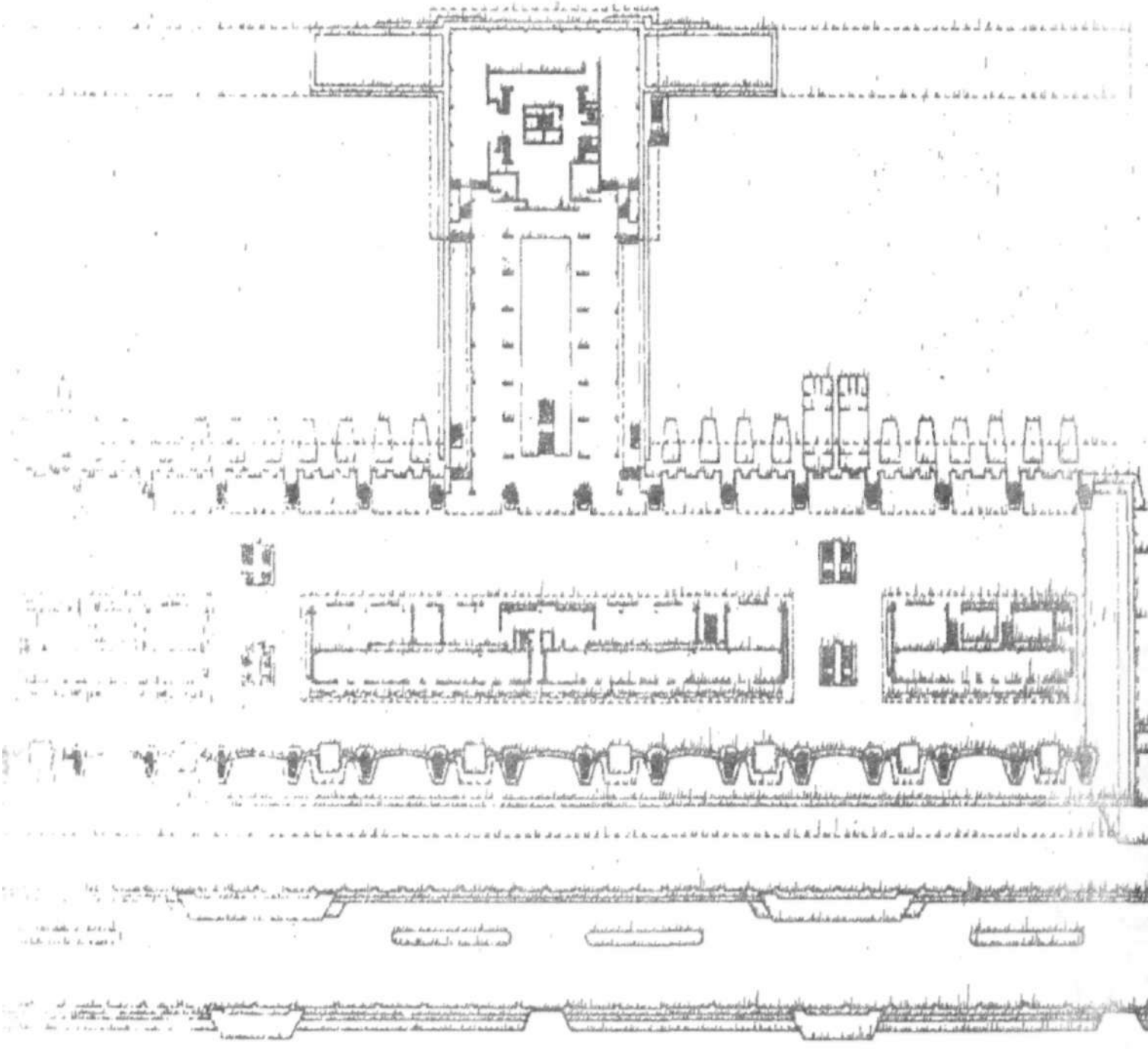
A balance flow, when established, for the enplaning and deplaning passengers and goods through the terminal complex will be such that flow is from curb, road, car paking and public transportation stops through the terminal complex to the aircraft and back again in reverse order. Volumes of passengers and goods at typical peak hours and resulting traffic by ground transportation vehicles must be established to determine the requirements for capacities of curbs, vehicular parking, and public transportation stations; terminal building areas including ticket lobbies, passenger holding areas, corrdor widths, inbound and out bound baggages; and the number of aircraft gate positions and associated areas of aircraft aprons. These requirements are all closely related to passenger volumes, airline schedules, runway capacity and number of operations by various types of aircraft.

## CASE - STUDIES

### 3.10 Dulles International Airport, Washington:

This airport was designed by Eero Saarinen in 1960 for the F.A.A. (Federal Aviation Authority) expl in his basic conception for Dulles shortly before his death, Saarinen has this to say:- "Federal Architecture is traditionally static, but we felt a jet airport should be non-static, expressing the movement and exitement of modern travel by air". Mobility was expressed by the adoption of the "mobile loonge" concept. Exicitement manifested itself by the dramatic monumentalization of technique. By the expressive, compact, 150 x 600 feet strong form rising from the plains and majestically hovering over it, Saarinen said:- "the roof should be tilted forward so the building would be seen .... Gradually, we arrived at the idea of a curred roof, high in the front, lower in the middle, rising again at the back." The roof is constructed of light suspension cables and in-situ concrete panels, supported by two rows of columns 120 metres apart. The concrete "trees" as Saarinen called them, are 65 feet high on the approach side, 40 feet high on the field side and they slope outwards to counteract the pull of the cables, their tilt exaggerated as is their rear compressive flange.

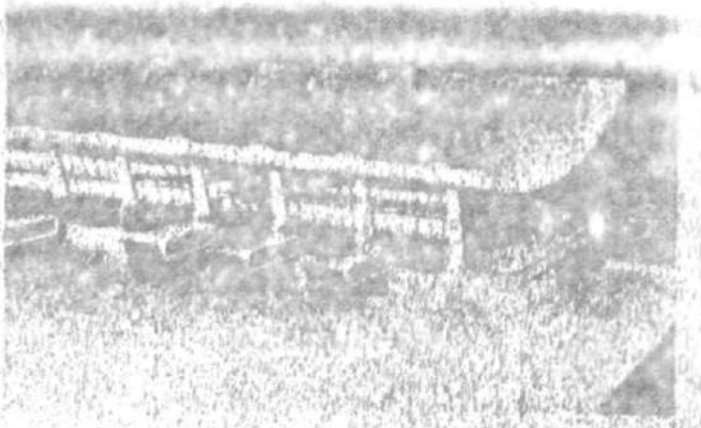
Passenger approach is on three levels flanking the front and forming a giant stairstep base. The sculptured concrete control tower is centred behind the terminal, its juxtapositioning acting as an axis of symmetry for the whole complex, both upon arrival and departure.



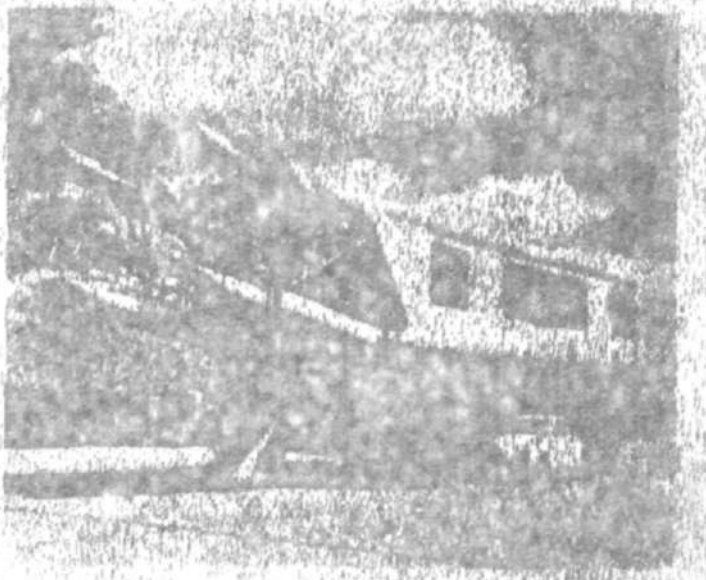
Internal circulation is bilevel. The upper level is for departures and the lower for arrivals. Passenger movement is a simple walk across the small width of this compact building.

In Washington D.C. there are three airport terminals: Dulles, Washington National and Adrews Airforce base. Dulles is under utilized compared to Washington National. National handled 15 (fiften) million passangers against Dulles 3.4 million. This is because National is in close proximity and more accessible to the major population centre of Washington. It is a 10 minutes taxi ride to the white house and is serviced by Washington Metro. In contrast Dulle's is 40 minutes from downtown and Metro connection is unlikely before 1990.

Since when this airport became operational. its use has reflected the trends and fortunes of the airlines that service it. Although the passenger local presently is five times that of the 1964 period, the number of flights has levelled off and declined recently. This is because of the introduction of stretched and wide-bodied jets like the DC 10 and Jumbo 747 on the longeange domestic and internctional flights. When Saarinen designed the airport, it was envisaged that maximum capacity of aircraft will be 150 passengers, but with the advent of this wide-bodied planes capable of carrying 350 - 500 passengers, the facility became inadequate. The evisaged lateral stretching of the terminal to provide more gates was not the best solution. Another problem which was caused by the unpredictable turns and trends of air travel has been the need for a more efficient customs processing facility. Because the terminal building was designed at a time when international travel was less important than domestic travel



108. *Dulles Airport Model with mobile passenger*



109. *Dulles Airport Model's Lounge*

108B. *Dulles Airport, Section.*



no proper customs facility is evident. Presently there is a make s hift customs areas.

In 1980 the architects, Hellmuth Obata and Kassabaum designed an extension to the present facility to ensure handling a greater passenger load per plane. The original terminal structure is preserved. The back doors leading to the mobile lounges was pushed out 50 feet towards the aircraft apron through a pair of low sheds appendaged to the south elevation and separated from each other by the connector to the control tower. Below, on the ground level, the baggage sorting area was enlarged. Security gates to the south wall and once again circulation will be unhampered with the security line bisecting the structure lengthwise.

The radical thing about Dulles is the idea of a mobile lounge. It is the opinion of James Wilding, director of Washington Methopolitan Airports, that without this concept Dulles would have required new construction 13 years ago. Another advantage of this concept is the elimination of fingergate construction, maintenanc and air-conditioning. Also the problems of jet-blast, taxing and noise is reduced because the planes will be parked half a mile away.

But this not standing, the major inconvenience with this terminal building is the time taken brom embarking on to the mobile lounge and the long drive at a snail speed of 20 m.p.h. you find that it more time to reach the aircraft than to go through the terminal proceedings. Also, the lounge is aspecialist austom-made desig Its applica tion here in gods own Nigeria will couse the usual

spa.xparts-manitenance.quagmire. So, I will not recommend its use. The so called advantage of jet bast jet noise passenger exposure can still be solved in a much practical and cheaper way without compromising the passenger-walking distance criteria.

3.20 Heathrow Airport - Terminal I:

Terminal one was designed in 1966 by the Firm of Frederick Gibberd and Partners. The partner in charge of the project George Dunton had this to say:-

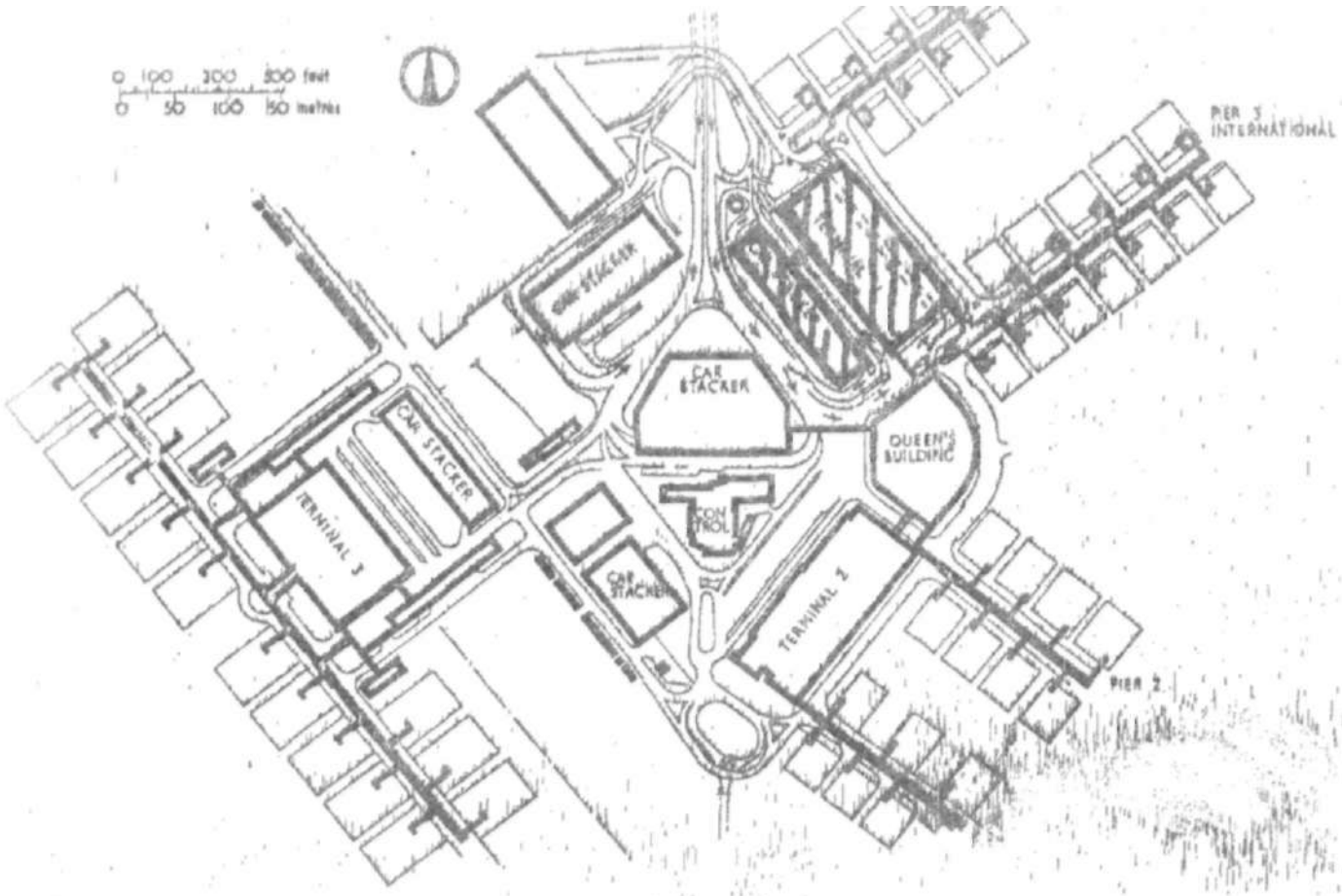
"We aimed at simplicity and clarity and the terminal building is in fact an extremely simple concept. It is a rectangular box divided horizontally arrivals on lower floor, departures on upper floor; and vertically - domestic to the left, international to eight". (diagram).

With the acceptance of this concept, the architects strived at preventing it getting confused because of the fact that additional requirements could introduce complexities which would destroy the simplicity and clarity they so sought. In itself, the terminal building is a complex piece of machinery for transfer ing people between different modes of transport. The building belongs to BAA (British Airports Authority) who rents it out to airline companies, concessionaires, customs, immigratily and Health control.

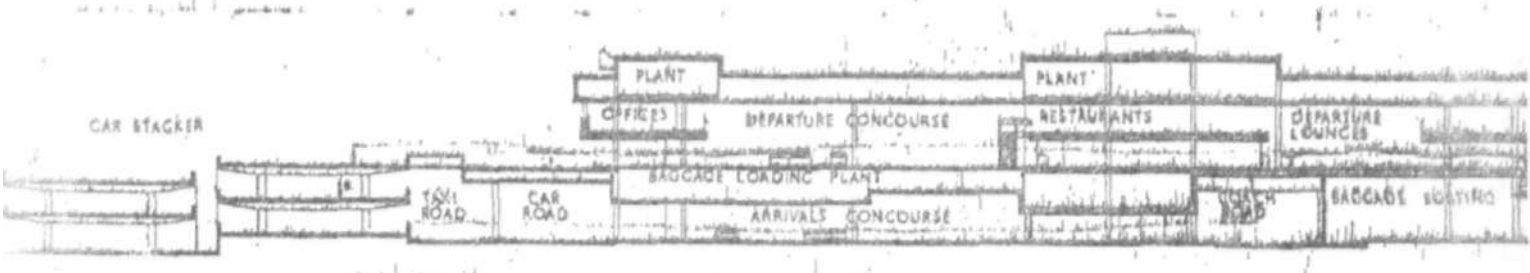
The Architectural Concept is such that the articulation of the subsystems that the building envelopes is matched by the articulation of the various building elements. George Dunton draws attention to this, thusi-

"There must be structural clarity"

"Columns (are seen to) carry loads"




SITE PLAN.




1:1600

SECTION

TERMINAL I
HEATHROW AIRPO
LONDON

"Flying beams self-evidently carry floors"

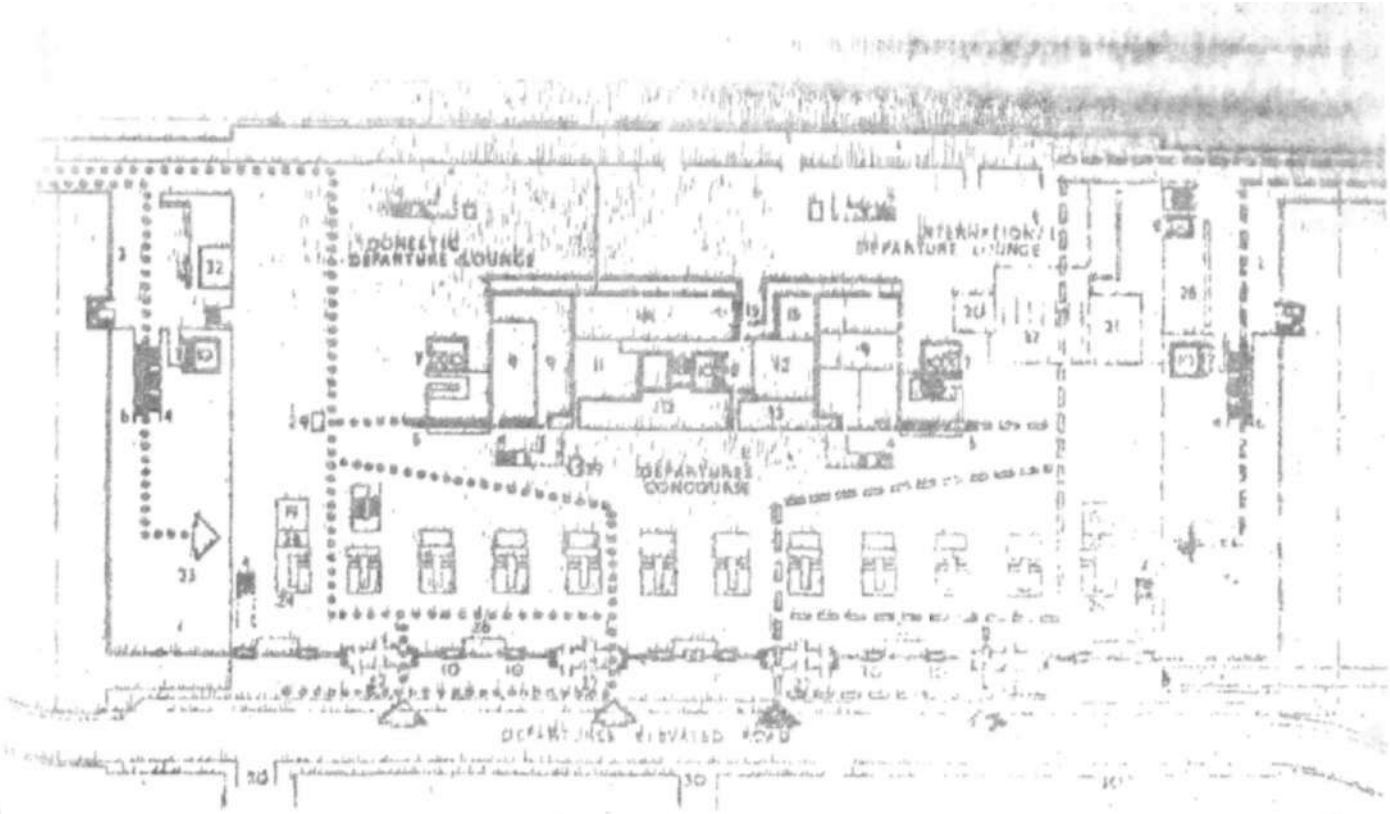
"The staircase is a ladder - a direct statement"

"Service shafts are not vehicles for carrying by-law notices but important architectural elements."

All this is very much part of George Dunton's architectural theory which is a continuation of the "flash gap" theory used at the Royal Festival Hall to separate the various elements. The interior is monochrome, based upon orange with the addition of various proportions of black or white. This affects paint finishes and carpets, and relate to natural materials - teak, aluminium, bronze and marble. The whole interior is neutral, interest and exitement being provided by the movement of people and by a large amount of quality furniture and fittings.

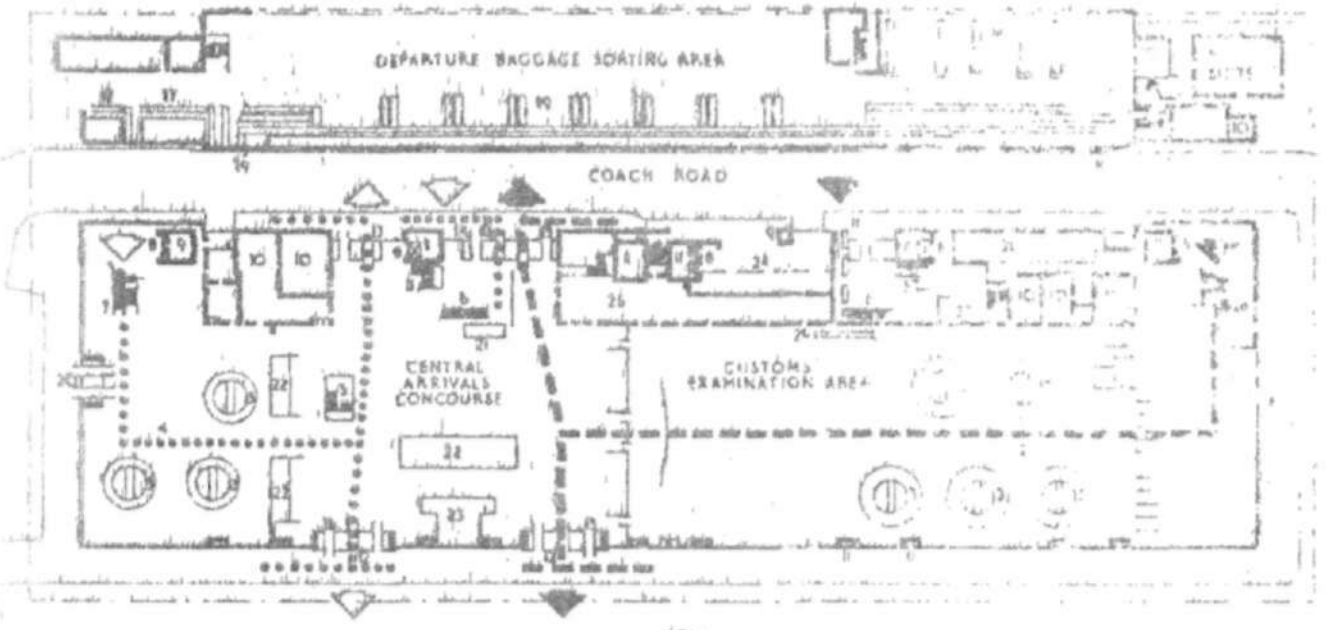
Equipments and services take a greater percentage of the building cost. Hot water is supplied from a boiler house which serves the whole central area at Heathrow. Except for a few spaces, the whole building is airconditioned, using either the central hot water supply or the terminal 1 cooling plant, and using induction unit systems (perimeter offices), low velocity conventional systems (internal spaces) and fair coil units (VIP Suites). Perimeter gilled tube low pressure systems heat the concourse areas and heated metal tile ceilings the baggage area.

Communications is such that landside systems deal with transport servicing. The passenger walks from one to the other and is largely, unaware of the alternative systems that surround his arrival and departure. Departure and arrivals passengers mix only in the piers and airside gallery. Domestic and international passengers mix only at the check in point on thedepartures level




Key

1 Bridge to pier
2 International arrivals balcony
3 Domestic arrivals balcony
4 Staircase
5 Escalators up from coaches
6 Escalator down to arrivals hall
7 Passenger lifts
8 Goods and baggage lifts
9 Passenger lavatories
10 Service ducts
11 Silver Wing lounge (BEA)
12 Nursery
13 Shopping parade
14 Bar preparation and storage
15 Duty free shop and cloths
16 Licensed bar
17 Taxi bay
18 Twenty-four-hour bus
19 Bookstall
20 Special branch offices
21 Customs and immigration offices
22 Departure immigration and customs combined
23 Customs examination
24 Check-in desks
25 Airline offices
26 Airline offices
27 Public address and departures bay
28 Transit lounge
29 Telephones
30 Bridge to satellite
31 Duty free shop
32 Lounge
33 Coach bays
34 Departures forecourt
35 Arrivals forecourt
36 Entrance to underground car park
37 Exit from underground car park




KEY TO CIRCULATION

DOMESTIC PASSENGER ARRIVALS
INTERNATIONAL PASSENGER ARRIVALS
DOMESTIC PASSENGER DEPARTURES
INTERNATIONAL PASSENGER DEPARTURES

TERMINAL I, HEATHROW AIRPORT, LONDON

and arrivals concourse below. Otherwise they follow separate routes established by sign posting. Very little spatial enclosures takes place and screens are used only for immigration and customs control or ∠ to give slight definition to the domestic luggage retrieval area. The anonymous way in which they achieve this is one of the barely percieved parts of the design. Passengers with time to separe may use the shops, restaueants lavatories and telephones. The policy has been to provide concessions and services in a role that is subservient to the main transfer function of the building.

When passengers arrive at the doors of the terminal they face a row of twelve check-in desks facing them. Passenger control begins with the issuance of a flight boarding card and instructions for assembly. Baggage enters its own conveyor system at this point and proceeds, independently of the passenger, to the aircraft.

While these two systems are operating, afurther one known as (PALC) passenger acceptance load control is taking place. Passenger numbers are aggregated from the check-in desks and from West London terminal, when passenger weight is calculated on an average weight system. Baggage is actually weighed and aggregated. This information is sent to aieside, where lact minute adjustments in the amount of fuel carried are made.

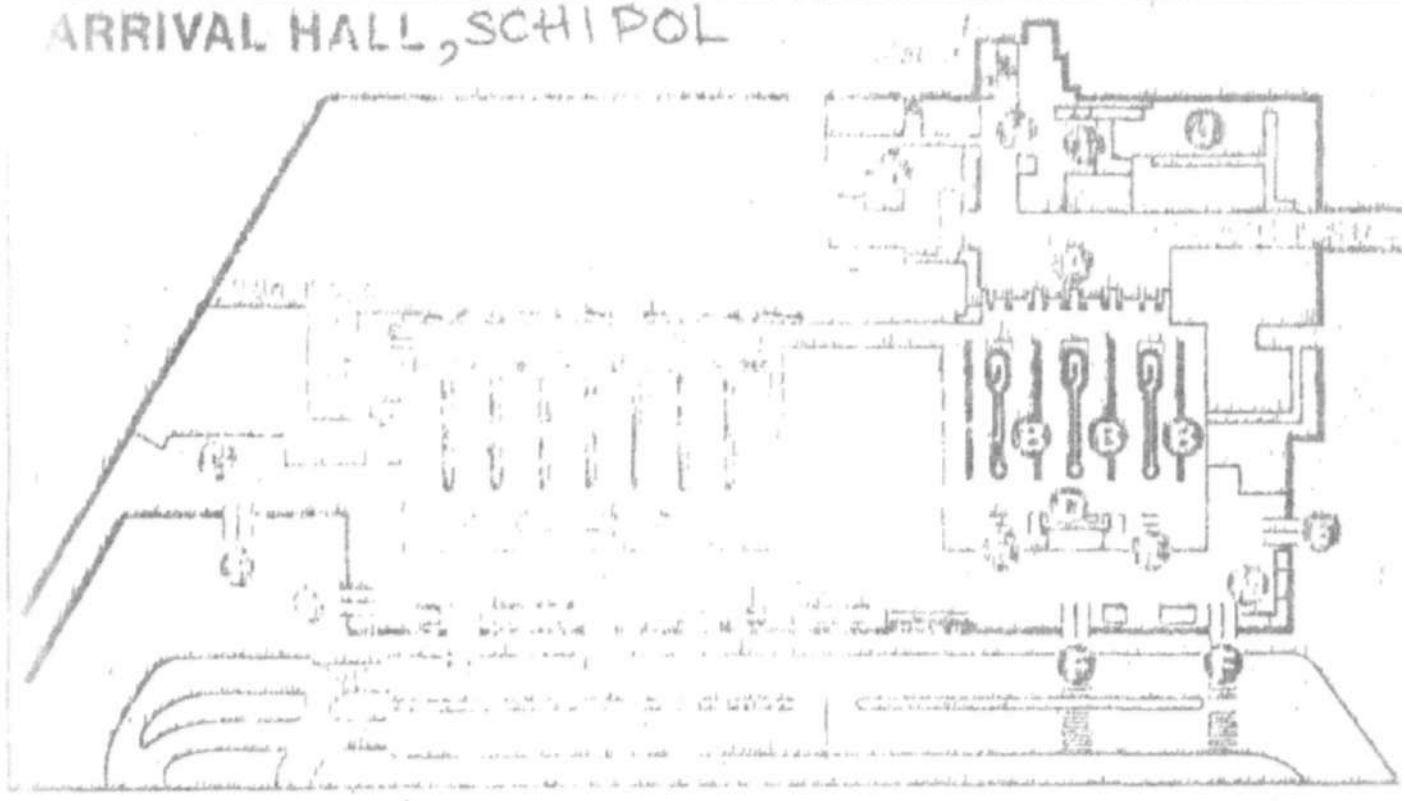
Baggage is placed upon the weighing platform at the check in deck by the passenger. This is also the first leg of the conveyor system. It passes from this to the next conveyor platform alonside the airline check-in clerk. In doing this, it breaks a magic eye and enters the solid state aircuit logic of

the conveyor system labels are now attached to it by the steward who then presses a dispatch button to sendit on its way. Another magic eye controls its movement from labelling on to main delivery belt because labelling conveyors are paired, and only one may operate at a time. The main delivery belt carries the baggage below the floor level onto one of the main conveyor belts once again with a waiting section so that an even distribution of luggage may be achieved.

Two conveyors carry the baggage to airside and normally these work in opposition so that two streams of baggage, balanced to maintain an equal flow, arrive at the airside sorting area. The conveyors pass two sorting stations, each manned by two men. The consulting engineers describe the next stage:- "The sorting is done by visual inspection of the label and each bag is routed by means of a selector button into the appropriate outlet. The selector button operates in conjunction with a pin drum controller which measures the distance of the sorter from the appropriate outlet and activates agate on the sorting belt as the selected bag approaches." There are fourteen out-lets from the conveyor belts organised into seven spurs. From here baggage is carried to waiting trucks parked along the edge of spur platform.

The trucks are then hitched to a tractor and towed across air side road which is skirted on the left by the the terminal building and on the right by the jet stream baffle. At the stand, baggage becomes part of the ground operations vehicles that surround the aircraft.

# ARRIVAL HALL, SCHIPOL



A immigration

B luggage collection (exits for charter flights)

C luggage collection (exits for scheduled flights)

D currency exchange

E customs

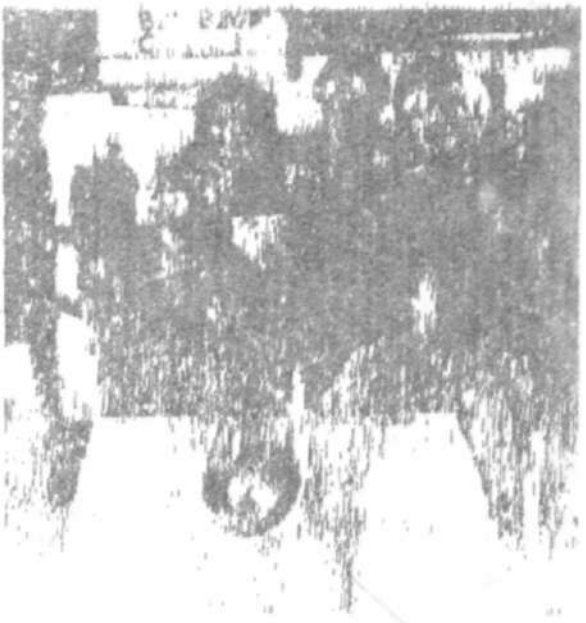
F exit to taxis and KLM coaches

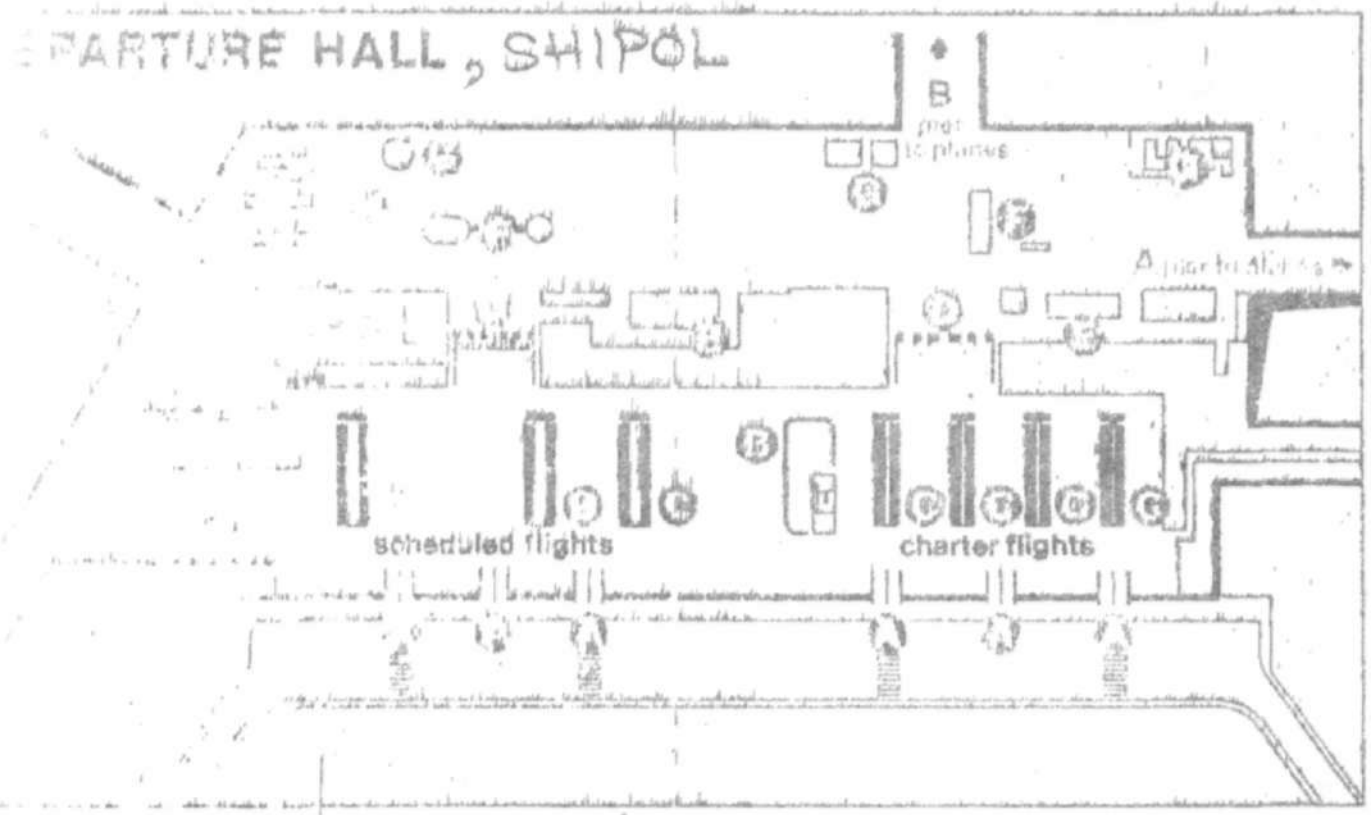
G check-in for domestic flights

H baby room
showers

I airport hotel (for transit passengers)

K VIP and conference rooms
KLM offices
SAS offices






entrance

KLM reconfirmation and reservation office

information desk

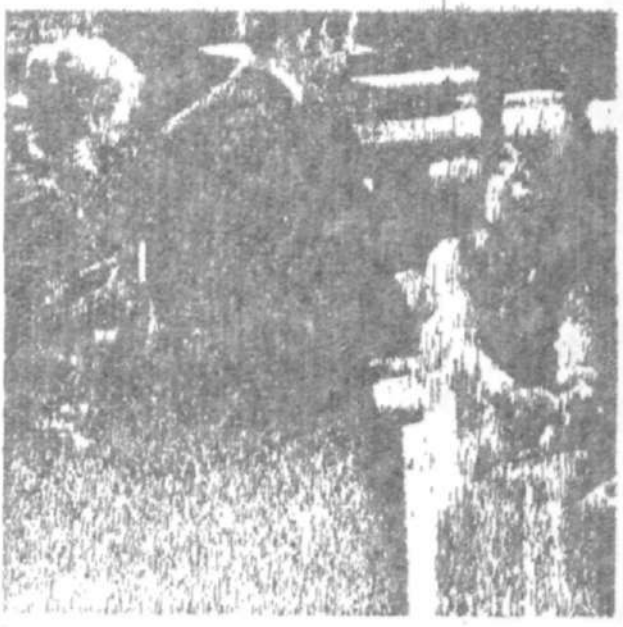
telephone booths

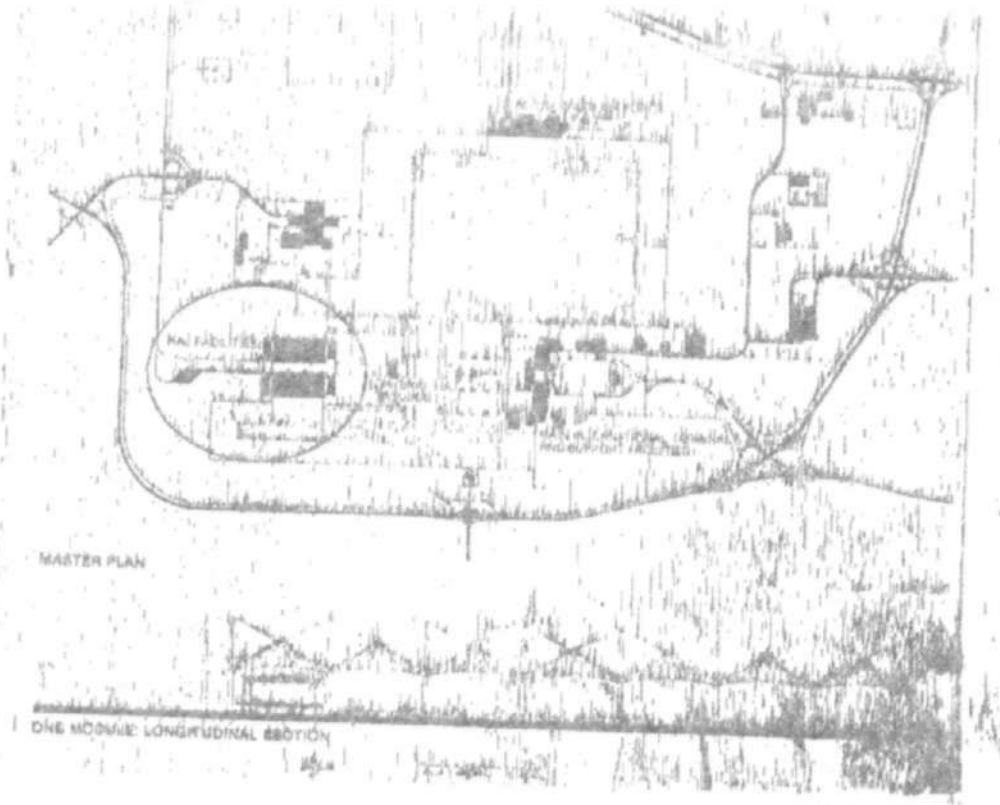
duty free shopping areas

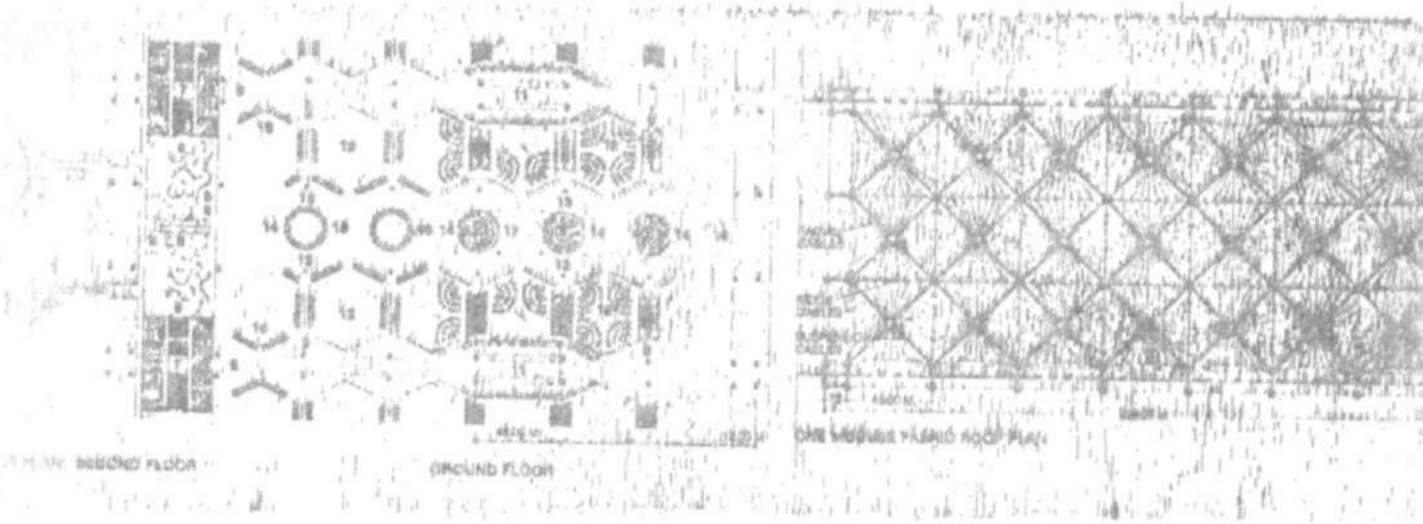
KLM information desk and currency exchange

toilets

to KLM First Class lounge






HADJ TERMINAL
JEDDA, SAUDI ARABIA.

## TERMINAL AREA CONCEPTS

4.00 In the selection of a terminal area concept, the following factors were considered and carefully studied for evaluation

4.01 Passengers:

(a) Adequate terminal area curb space for private and public transportation.

(b) Minimum walking distance - automobile parking to ticket counter.

(c) Minimum walking distance - ticket counter to passenger holding area.

(d) Minimum walking distance - holding area to aircraft.

(e) Passenger transportation - where long distances must be traversed.

(f) Pedestrian walkways to aircraft - as back up to mechanical transportation systems for passengers.

(g) Efficiency of passenger interline connection.

(h) Baggage handling - enplaning.

(i) Baggage handling - deplaning.

(j) Convenant hotel - motel accomodations.

(k) Efficient handling of visitors and sightseers at the airport.

4.02 Passenger Vehicles:

(a) Public automobile flow separation from service and commercial traffic.

(b) Public transportation to and from the airport.

(c) Public parking - long term (3 hours or more).

(d) Public parking - short term (less than 3 hours).

(e) Airport employee parking.

(f) Airline employee parking.

(g) Public auto service area.

(h) Rental car parking and service areas.

4.03 Airport Operations:

(a) Flexibility.

(b) Separation of apron vehicles from moving and parked aircraft.

(c) Passenger flow separation in the terminal building (departing and arriving).

(d) Passenger flow separation from apron activities.

(e) Concession availability and exposure to public.

(f) Air-field security and prevention of unauthorized access to apron and airfield.

(g) Air cargo and freight forwarder facilitioes.

(h) Airport maintenance shop and facilities.

(i) Airfield and apron drainage.

(j) Utility plants, and heating and air conditioning systems.

(k) Fire and rescue facilities and equipments.

4.04 Aircraft:

(a) Efficient aircraft flow on aprons and between terminal aprons and taxi-ways.

(b) Easy and efficient maneuvering of aircraft parking at gate positions.

(c) Aircraft fueling.

(d) Heliport area.

(e) General aviation area.

(f) Noise, fumes and blast control.

(g) Apron space for staging and maneuvering of aircraft service equipment.

4.05 Safety and Secvrity:

Safety has to be ensvrcd for the following functions and areas.

(a) Emplaning and deplaning at aircraft.

(b) Elevators, escalators, stairs and ramps as to location, speed, and methods of egress and ingress.

(c) People-mover systems as to location, speed, method of egress and ingress.

(d) Road crossings as to protection of pedectrians.

(e) Provision for disabled persons.

4.06 Expansion Capabilities to Accomodate:

(a) Increase of passenger volumes.

(b) Increase in number of air craft positions.

(c) Increase in aircraft size.

4.07 Economics:

And above all to provide a proper balance between capital investment, aesthetic, operation and maintenance costs and passenger and airport revenues.

4.08

The following terminal area concepts exist with their different variations:-

(1) Simple Terminals.

(2) Pier Terminals.

(3) Satellite Terminals.

(4) Mobile Lounge Terminals.

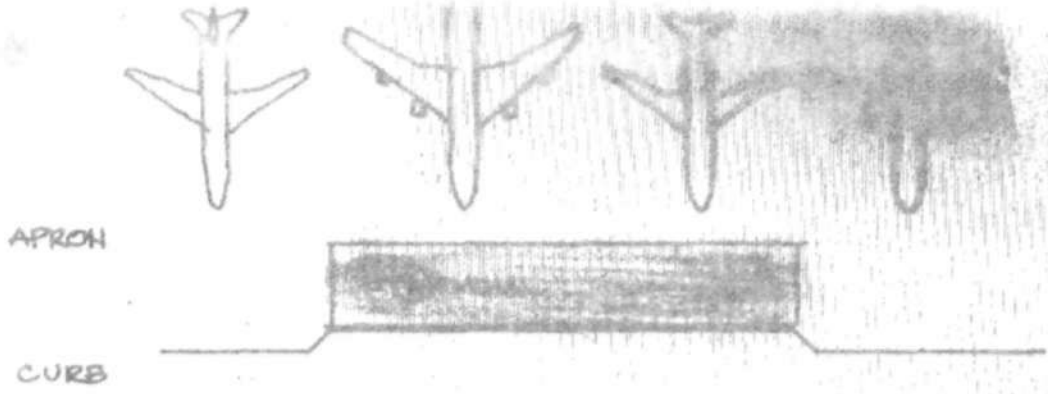
(5) Unit Terminals Based on a Modular System.

4.10 Simple Terminals (Figure Tac. 1)

The simple terminal consists of a single common waiting and ticketing area with several exits onto a small aircraft parking apron. It is adaptable to airports with low airline activity and is also adaptableto general aivation operations whether it is locate? as a separate entity on a large air-line-served airport or is the operational centre for an airport used exclusively by general aviation. Where the simple terminal serves airline operations, it will usually have an apron which provides close-in parking for three to six commercial aircraft. Where the simple terminal serves general airation only, it should be within convenient walking distance of aircraft parking areas and should be adjacent to an aircraft service apron. The simple terminal will normally consist of a single level structure where access to aircraft is afforded by awalk across the aircraft parking apron. The layout of simple terminal should take into account the possibility of linear extension for terminal expansion.

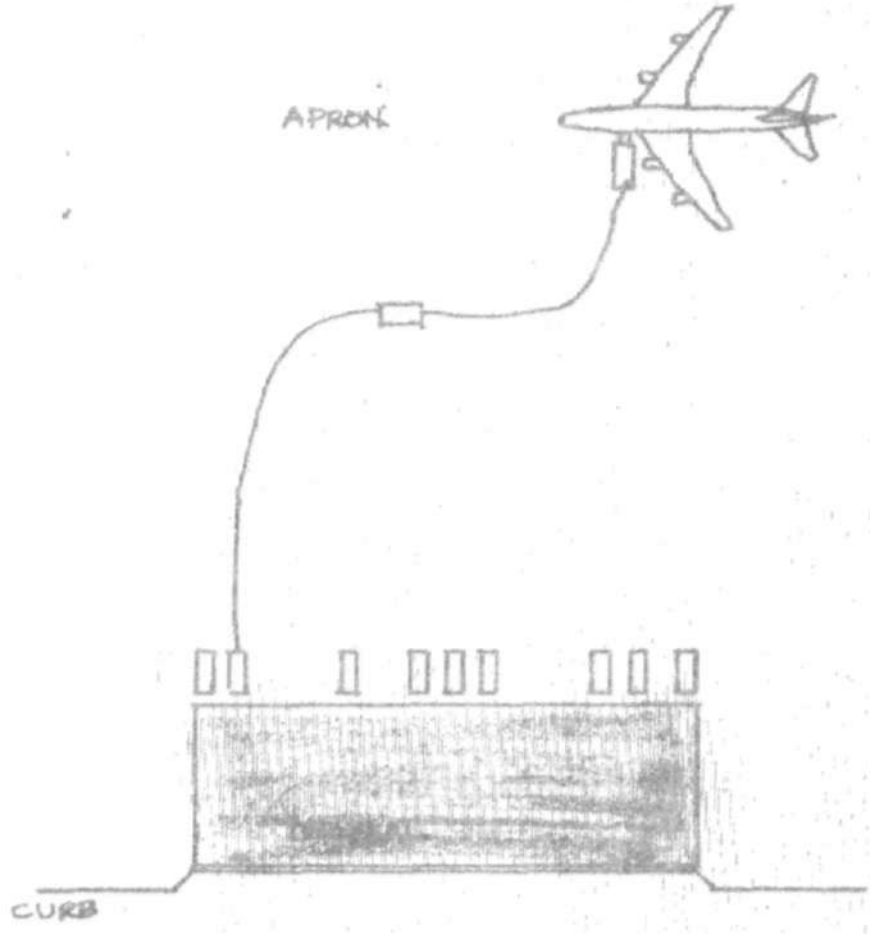
4.20 Linear Terminals:

The linear terminal concept is mar:ly an extension of the simple terminal concept, that is, the simple terminal is repeated




* SIMPLE TERMINAL CONCEPT — VARIATION LINEAR TERMINAL 4a

4b




* MOBILE LOUNGE OR TRANSPORTER CONCEPT. 4b

in a linear extension to provide additional apron frontage, more gates, and more room within the terminal for passenger processing. It is sometimes referred to as the gate-arrival concept. The more sophisticated linear terminals often feature a two-level structure where enplaning passengers are processed direct from curb to aircraft on one level while theother level is used by deplaning passengers for baggage claim and access to ground transportation. Passenger walking distance from curb through terminal to aircraft is short, usually 22.5 metres to 30 meters. The linear configuration also lends itself to the development of adequate close-in public parking. Ample frontage for loading and unloading ground transportation vehicles is provided with each extension of the linear terminal and there is a direct relationship of enplaning or deplaning curb frontage to departing or arriving aircraft. Linear terminals can be expanded with almost no interference to passenger precessing or aircraft operation. Expansion may be accomplished by linear extension of existing structure or by developing two or more linear terminal units.

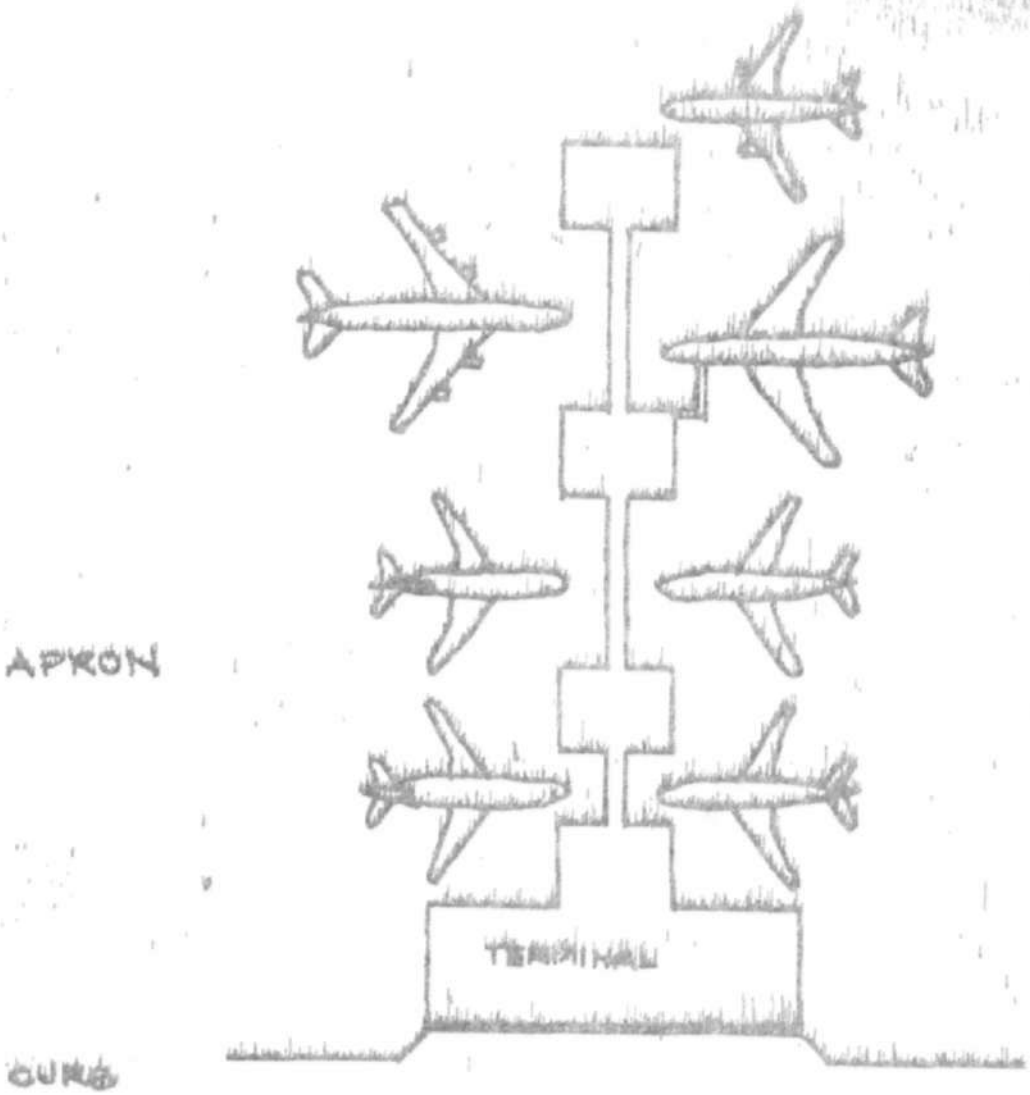
The loading of aircraft may be accomplished by nose-in/ push-out operations or by loading bridges. Aircraft can maneuver on apron areas with un-obstructed flow if a maneuvering taxi. Lane and dual taxiway parallels are provided. The linear concept does not require long concourses, fingers, satellites, or service buildings, but it does lend itself to common facilities such as waiting rooms, concessions, ticket counters, or hold rooms. These facilities are usually repeated with each linear extension. At large airports, this concept can also lead to an extensive requirements for systems of directional signs since

enplaning passengers must not only be directed to the correct airline area but also to the correct passenger processing module, within that area. Another problem with this concept is that on a return flight to the airport, a passenger may find that his deplaning module is located along distance from where he parked his car at his enplaning module. These factors must be taken into account in comparing the operating and construction costs of the linear terminal with other concepts. The configuration of the space occupied by the linear concept must also be compared with the space and configuration of other concepts in dete mining their compatibility with particular airport situations.

4.30 Finger Terminals:

The finger or pier concept evolved in the 1950's when gate concourses were added to simple central terminal buildings. Since then very sophisticated forms of the concept have been developed with the addition of hold rooms at gates, getways and aircraft loading bridges, and vertical separation of the ticketing check-in function from the baggage claim function. However, the basic concept has not changed in that the main central terminal building is used to process passengers and baggage, while the finger or pier provides a means of enclosed access from the central terminal to aircraft gate. Aircrafts are parked at gates along the pier as opposed to the satellite concept where they are parked in a cluster at the end of a concourse.

Walking distances through finger terminals are long, averaging 120 metres or more. Curb space must be carefully planned




PIER CONCEPT OR FINGER TERMINAL
EXAMPLE— MURTALA MUHAMMED AIRPORT, LAGOS. 4-C

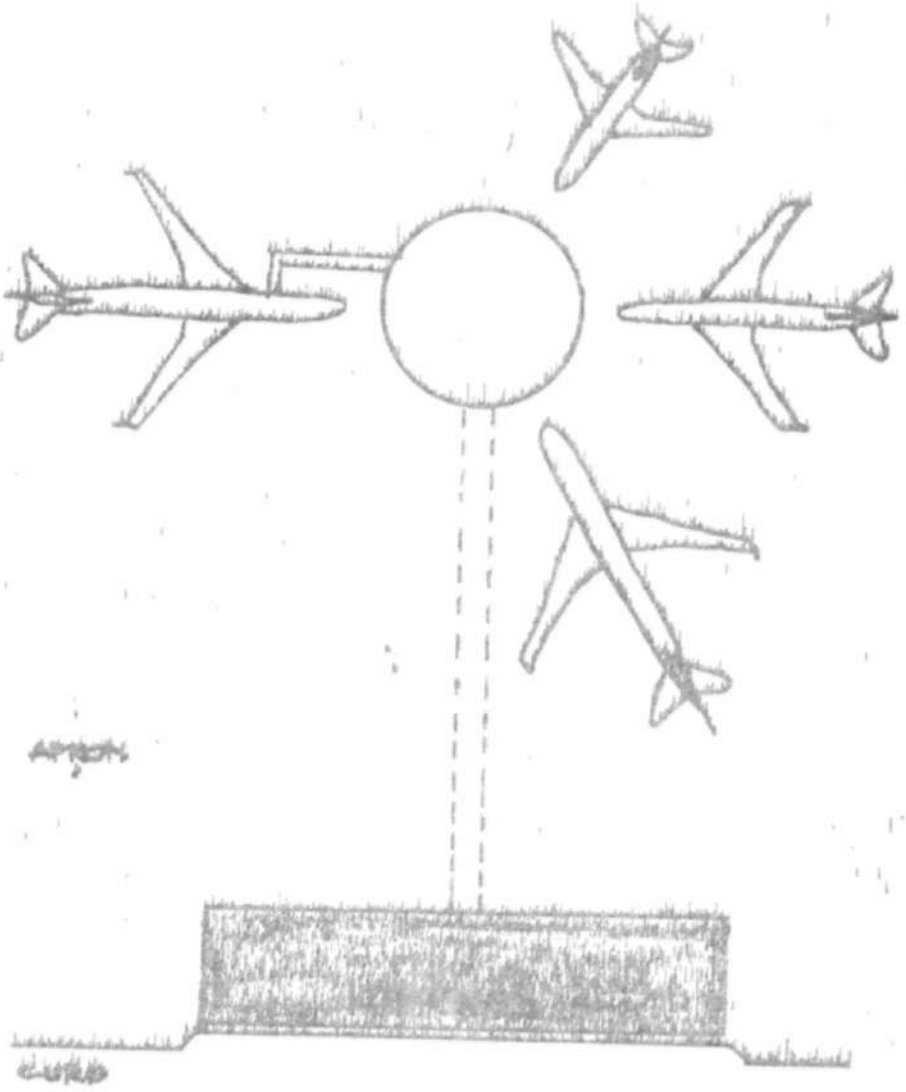
since it depends on the length .of the central terminal and is not related to the total number of gates afforded by fingers. This is particularly true of deplaning curbs near centralised baggage claim areas.

Although the finger concept has afforded one of the most economical means of adding gate positions to existing terminals, its use for expansion should not be extended at the expense of taxiway maneuverability nor should new fingers be added without adequate space for passenger processing in the main terminal. Most successful additions are effected by extending the main terminal and then increasing, the number of fingers.

Adequate space must be provided between fingers for the maneuvering of aircraft. Dual taxi capability between fingers is desirable and aircraft growth should be taken into account in planning separation since most aircraft maneuvering takes place between piers, outside taxiways are free for push-out operations.

4.40 Satellite Terminals:

The primary feature of the satellite concept is the provision of a single central terminal (with all ticketing, baggage handling, and ancillary services) which is conneceted by concourses to one or more satellite structures. It is sometimes called the rotunda concept. The features of the satellite concept are very similar to those of the finger or pier concept except that aircraft gates are located at the end of a long concourse rather than being spaced at even intervals along the concourse. Satellite gates are usually served by a common hold room rather than indivisual hold rooms. Another feature is that the concourse can be located underground thereby providing space for aircraft taxi operations between




SATELLITE TERMINALS OR "ROTUNDA" CONCEPT

the main terminal and the satellite.

The distance from the main terminal to a satellite is usually well above the average distance to gates found with the finger concept. Therefore people-mover systems as being provided between terminal and, satellite and many installations to reduce walking distances.

There is no direct relationship between the number of gates and curb space, so special care must be taken in planning enplanning and deplaning ramps for the central terminal to prevent curb over-loads. One advantange of the satellite concept is that it lends itself to a compact central terminal with common areas for processing passengers. In some instances, where terminal area space is limited, structural parking is provided above the central terminal building.

Aircraft maneuvering areas are required around satellites so that push-out tug operations do not cause aircraft to block active taxiways. Wedge shaped aircraft parking positions around the satellite tend to crowd the operation of aircraft servicing equipment.

Terminals developed under the satellite concept are difficult to expand without reducing ramp frontage or disrupting support operations. Therefore, increases in terminal capacity are usually effected by the addition of terminal units rather than expansion of an existing unit. Satellite terminals can be of the centralised or decentralised types.

4.15 Mobile Lounge Terminals:

The mobile lounge or passenger transporter concept is in use at Dulles International Airport. It is sometimes called the remote aircraft parking concept. Aircraft parking aprons are remote from theterminal building. The mobile lounges transport passengers from the building to aircraft and can be used as hold rooms at terminal building gate positions. In this concept, the aircraft gate positions are placed in parallel rows at required spacings while mobile lounge and service VEHICLE roads running between the parallel rows of aircraft. Several sets of parallel aircraft parking rows can be provided for ultimate development of gate positions. Airline operations buildings must be provided adjacent to aircraft parking aprons. With themobile lounge concept, walking distances are held to a minimum since the compact terminal building contains common passenger processing facilities and curb frontage can be directly located across the terminal building from the mobile lounge gates. Building and curb length, which is established in part by the number of mobile lounge gates, must be carefully planned to provide adequate frontage for enplaning and deplaning passengers.

The concept has good extension capability in that canacity can be increased by the addition of mobile lounges and the main terminal and aprons can be expanded without the addition of extensive concourses, fingers or satellites. With the mobile lounge concept, additions can be made with little impedance to airport operations and aircraft movements.

Aircraft maneuvering capability is excellent with this concept. Remote aircraft parking reduce taxi time and distance to

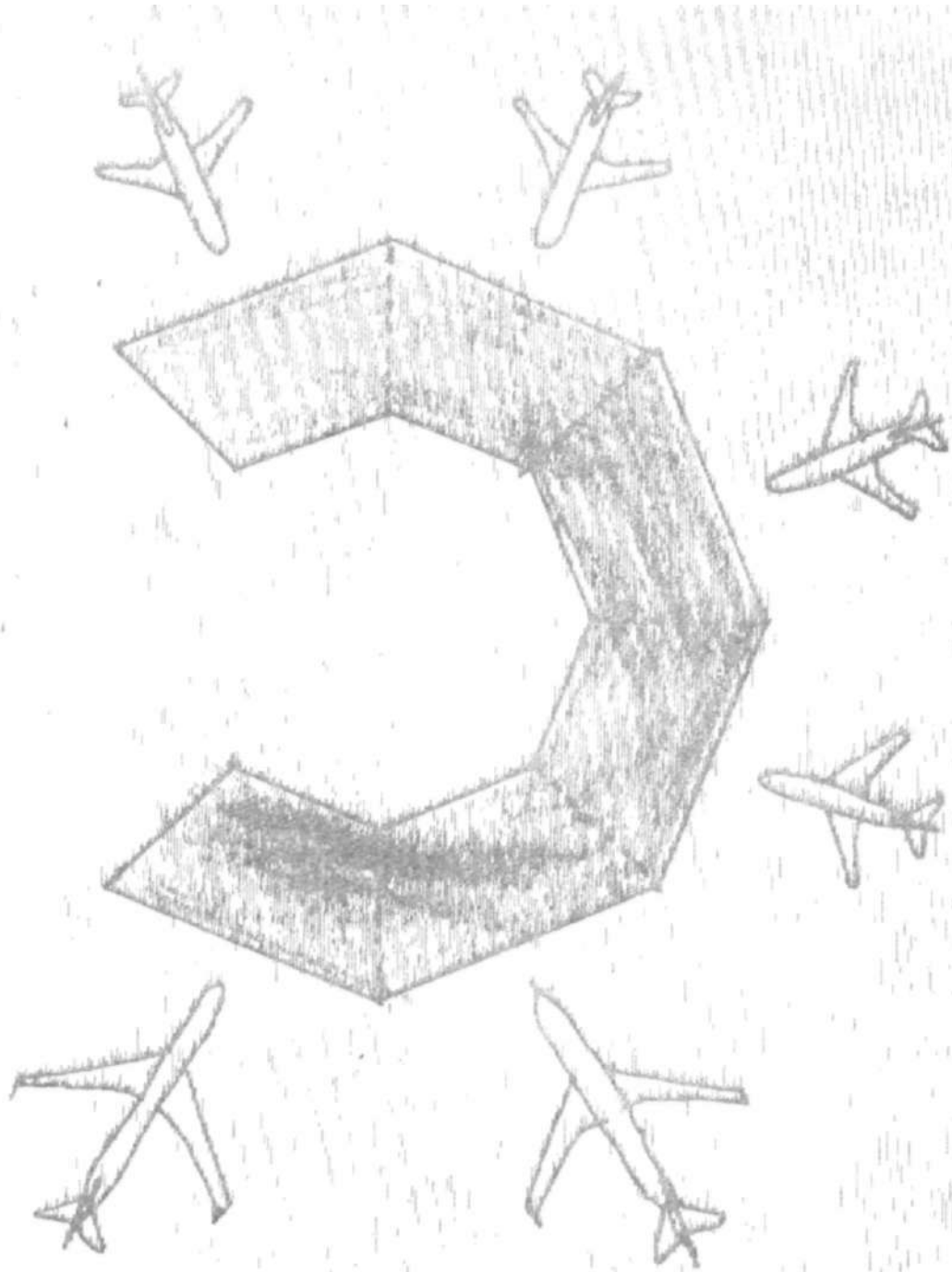
runways and avoid aircraft congestion next to terminal building facilities. This also removes the aircraft noise and jet blast problem from thebuilding area. Mobile lounges must be capable of mating with various aircraft sill heights and terminal building floor heights. In comparing the mobile lounge concept with other concepts, the cost of independent terminal and service buildings and the purchase and maintenance of mobile lounges must be considered. The time required to move passengers between terminal and aircraft by mobile lounge should also be taken into account.

4.60 Modular Based Terminals:

These are terminals designed such that expansion can be achieved by repetition of the basic module. The best configuration is not linear but as part of a circle or a polygon. This allows for compactness.

Passenger movement is a simple walk across theterminal, the walking distance being average. It is usually a bi-level structure for separation of departing and arriving passengers and the possible use of aero-bridges.

The advantage of this type of terminal is that the development of the terminal building can be phased and a considerable discount obtained on theinitial capital out-lay. It is of great help in developing countries, where money is a constraint and as such building the whole complex piece-meal is untenable. Also, it affords to solve the problem of unpredictable growth in the aviation industry.



MODULAR BASED TERMINAL 46

## 5.00 FORECASTS AND DEMAND/CAPACITY/ANALYSIS

The Master Plan of any airport in theworld is developed on the basis of forecast which helps in establishing relationships between demand and capacity for the various airport facility require-ments. Forecast are usually for short, intermediate and long range periods (five, ten and 20 years), thus affording the authorities and the design team to establish a schedule of development for improvements e.g. adoption of a phased contruction which will result in a discounted cost on the over-all investment because of a reduction in initial capital outlay.

Today's airport crisis can be attributed in part to the inadequacies of past forecast which have tended to underestimate aviation demand. The shortcomings of past forecast raise questions as to what forecasts should encompass to provide proper guidance for the development of a master plan for the particular airport. The radical designer will almost certainly go beyond the aviation demand forecast, and study the impacts which social,environmental,economic and technical forecasts will have on the airport in questions.

### 5.10 Forecast Factors:

In general the following factors affect forecast:- demography, disposable personal income per capita, economic activity and status of Industries, geographical factors, competitive position re other modes of transportation, sociological factors, political factors and airport traffic data.

5.11 Demography:

The size and structuring of the areas population and its potential growthrate are very fundamental factors in creating the demand for travel by air. The existing population along with its changing age, educational and occupational distributions can provide an index of the potential size of the airtravel market and resultant airport employment over the phased airport development period.

5.12 Disposable Personal Income Per Capita:

This isthe purchasing power available to the residents in the immediate vincinity of the area the arirport is supposed to serve in any one priod of time. This is a good pointer of average standard of living and financials wherewithat to travel. The higher the level of average personal disposable income, the greater the demand on airtravel.

5.13 Economic Activity and Status of Industries:

Business aviation and airfrieght traffic will be more when you have industries which depend on airfrieght for their rant materiab delivery and conyevance of their goods to the market. The higher the level of economic activity the more likely hold of business executives jetting in and out of the area the airport is enuisaged to serve.

5.14 Geographical Factors:

The geographical distribution and distances between populations and commercial centres within the area the airport is to serve,will have an impact on the type of transportation services required. Alternative modes of transportation may not be available, economically

feasible or simply inconvenient. Example is anyone who wants to trarel to Europe in theNorthern States will have to choose flying from Kano or Lagos; other modes of transportation will border on the eccentric or adventerous.

5.15 Competitive Position:

The demand for air service, also depends or on its present and future ability to compete with alternative modes of transportation. Also tecomological advances in aircraft design and in other transportation modes as well as industrial and marketing processes, can create transportation demands which here not previously existed.

5.16 Sociological Factors:

The trend towards a more urbanized and hetereogeneous society, the increasing horizontal and vertical social mobility of the populace through rising educational levels, social sophistry and the possibility of shorter work week (thanks to the machines and robots) with the resultant increase in leisure time are also mahor factors in determining demand for aviation services.

5.17 Political Factors:

A bitateral agreement between governments of different countries in regards to the aviation industry can result in the granting of new: traffic rights and routes for international air-service. This can affect the traffic volume at the affected airports. Demand for the aviation industry can also depend on governmental impositions of taxes, fees, and foreign surcharge

restriction. Additionally, the degree of governmental commitment to the development of alter native modes of transportation may affect airtravel demand.

5.18 Airport Traffic Data:

Last, but not the least; historical airport traffidata should be considered in the forecasting of future airport traffic. This data includes passenger and air cargo traffic, and air carrier, (scheduled airlines), general aviation and military aircraft movement.

5.20 Research of Area Forecast:

To develop forecasts for all the above forecast factors would bea huge task. Such extensive development of forecast should not be neccessary in the preparation of a master plan for an indivisual airport. Usually, forecasts which cover these factors will have been developed as part of other community planning efforts.

Therefore the airport master planner should conduct a research of forecasts which have been developed for the area and update them to the master plan effort. Discussions should be made with the planning agencies responsible for the development of these forecasts besause of their enitimacy with the area with the view of obtaining valuable assistance in the projection of travel demand.

5.30 Forecasting:

After deciding the most vital ofthe forecast factors for the development of the master plan, the planner should research related forecast efforts to avoid, duplication of effort. Sound forecasting is basically a common-sense analysis of the important factors that account for air travel demand. Good judgement which

stems from a keen analytical ability and a stock of experience is essential in formulating predictions based on inadequate or in conclusive data. Forecasting, it can therefore be said, is not an exact science but the application of judgement which becomes more accurate through practice.

Various parameters are useful in evaluating forecast but they cannot provide exact measures of success. They include:-

5.31 Consistency with past trends;

5.32 Comparison of directions of forecasted trends and realization;

5.33 Comparisons of rate of change;

5.34 Percentage deviations of forecast from actual values and

5.35 Comparisons of economic indicators.

5.40 Forecasting Methods:

There are many ways in which to forecast future demands and the different forecasting methods are not necessarily competitive with one another. In some instances one method serves to supplement another. Some methods are applicable primarily to the very near future, while others are best suited for longer range forecasting. What is being forecasted also narrows the numbers of suitable methods. An appropriate forecasting method can best be selected when the various possible approaches are known, including the peculiarities of each. Brief descriptions of the principal forecasting methods are given underneath for easier forecasts of aeronautical activities:-

situations etc. It is especvally advantageous when used in conjuction with any oftheabove methods, where there are a large number of variables for which relatively little data is available or when intangible factors are expected to play amajor role. The resultant forecasts from use of this method alone are the most difficult to defend under close scrutiny and may be subject to strong bias from the indivisual involved in the forecasting process.

5.45 Professional Services:

The preparation of forecasts is a complex task and should be accomplished by experienced foreeaster. This is especially true for airports serving large metropolitan areas.

5.50 Forecast of Aviation Demand:

Annual forecasts of airporttrafic (for 5 -, 10 -, and 20 - year periods) form the primary basis for determining the requirements for a master plan airport. It isessential to develop activity forecasts by the type of major user categories, i.e., air carrier, scheduled air taxi, general aviation and military. In the development of the operational activity forecasts, an unconstrained approach is usually the best approach. Forecasts are sometimes expressed in terms of upper and lower limits of estimated aviation demand for given points in time. These upper and lower limits are then plotted against the forecast period so that planners can develop alternative scheduling of improvements proposed in the master plan.

The "unconstrained" forecast represents the potential aviation market in which all the basic factors that tend to

create aviation demand are used, without regard to any constraining circumstance (i.e,limited air port expansion capability, airspaces, access etc.) that could affect aviation growth at any specific airport or location. Using this approach, it is possible to determine thetheoretical development needs in accordance with the total demand potential. For an airport serving an exceptionally high activity metropolitan area, however, potential constraints and alternative methods to reduce them should be considered necessary to determine airport requirements. They are listed and described below.

5.51 Enplaning Passengers:

Total number of passengers departing on aircraft at an airport, including originations, stop-overs, and transfer passengers. Where applicable identification should be established between domentic and international passengers separatgly.

5.52 Enplaning Air Cargo:

Total tonnage of priority, non-priority, foreign mail, express, and freight (property other than baggage accompanying passengers) departing on aircraft at an airport, including originations stopovers, and tranfer cargo. Where applicable indentification should be established between domestic and international cargo separately.

5.53 Aircraft Operations (Movements):

Total number of landings (arrivals) and take-offs (departures) from an airport is what is called aircraft movement or operation.

There are two types of operations - local and iterant; and is this identified separately:-

(a) Local operation's:- Aircraft which operate in the local traffic pattern or within sight of the tower and are known to be departing for or arriving from flights in local practice areas located within 20 mile radius of the airport and/or control tower, and aircraft which execute simulated instrument approaches or low passes at the airport.

(b) I tinerant Operations:- All aircraft arrivals and departures other than local operations described abore. Where applicable, identification should be established between domestic and international itinerant operation's separately.

5.54 Busy-Hour Operation's:

Total number of aircraft operation's that are expected to occur at an airport, averaged for two adjacent peak hours of a typical high activity day (use the 37th high activity day of the year) I dentify busy-hour operations by each category of major user.

5.55 Based Aircraft:

Total number of active general aviation and air carrier aircraft which use an airport as "home base" and have a current airworthiness certificate. Based aircraft should be categorized by gross weight, number and type of engines, and carrier or general aviation use.

5.56 Aircraft Mix:

In determining and planning for future airport facility requirement, it is necessary to forecast the types of aircraft mix which are to be accommodated at, the airport or location under considerations.

Therefore, it is necessary to keep abreast of technologycal advances in aircraft design (such as the SST (supersonic transport), large capacity sonic transport aircraft, V/STOL, air bus aircraft etc) in order to ensure the provision of adequate air field and terminal design at the airport from which they are to operate. Generally, passenger and cargo volomer forecast will indicate the types of terminal facilities required whereas, the number of aircraft operations by type will establish airfield configuration requirements.

5.60 Demand Capacity Analysis:

Demand/capacity analysis is an essential step in the development of a master plan for the indivisual airport. It provides basic information for determination of facility requirements and economic feasibility. The study of the demand/capacity relationship will result in a requirement for the theorotical expansion of facilities andthe cost of these improvements can then be related to revenues and to saving which will be realized by passengers, cargo handlers, and aircraft operators due to reductions in delay. This type of analysis should be applied to aircraft operations versue airfield improvements; to passenger enplanements versus terminal building improvements, to cargo tonnage versus cargo facility development, to airport access traffic versus access roads and rapid transit facilities; and

to other improvements as may be appropriate. Demand/Capacity analysis should be applied for short, intermediate and long range developments.

It should be kept in mind, however, that only approximations will be obtained for facility requirements, their costs, and savings which will result from reduced delays to airport users as well as anticipated revenues which may be obtained from proposed improvements. Thus demand/capacity analysis will yield preliminary estimates of number and configuration of run ways, areas of apron, numberof vehicle parking spaces, and capacities of airport access facilities. These approximations will provide a basis for developing the details of the airport plan and for determining the feasibility, of improvements considered there in.

5.70 Aircraft Operational Requirements:

The forecasts of aviation activity will indicate the kinds of aircraft which will use the Master Plan airport. The frequency of use, passenger/cargo load factors, and haul lengths will also be indicated. From this demand data, the planner can ascertain the required physical dimensions of the aircraft operational areas. While a capacity analysis provides requirements in terms of number of run-ways/taxi-ways etc., the analysis of aircraft operational requirements allows for the determination of run-way/taxi-way/apron dimensions and lateral clearances between airport areas. Consultation with air lines and thegeneral aviation community is essential in verifying forecast equipment usage and in ascertaining user plans.

5.80 Capacity Analysis:

An analysis of the existing air traffic capacity ofthe area

Table 6.1 Airport Capacities for Long Range Planning Purposes

| Layout | Description | Mix | PANCAP | PHOCAP IFR | PHOCAP VFR |
|---|---|---|---|---|---|
| A | [illegible] | 1 | 215,000 | 53 | 99 |
| | [illegible] | 2 | 195,000 | 52 | 76 |
| | [illegible] | 3 | 180,000 | 44 | 54 |
| | | 4 | 170,000 | 42 | 45 |
| B | [illegible] | 1 | 385,000 | 64 | 198 |
| | [illegible] | 2 | 330,000 | 63 | 152 |
| | | 3 | 295,000 | 55 | 108 |
| | | 4 | 290,000 | 54 | 90 |
| C | [illegible] | 1 | 425,000 | 79 | 148 |
| | [illegible] | 2 | 390,000 | 79 | 152 |
| | | 3 | 355,000 | 79 | 108 |
| | | 4 | 330,000 | 74 | 90 |
| D | [illegible] | 1 | 430,000 | 106 | 198 |
| | [illegible] | 2 | 390,000 | 104 | 152 |
| | | 3 | 360,000 | 82 | 108 |
| | | 4 | 340,000 | 84 | 90 |
| E | [illegible] | 1 | 770,000 | 128 | 396 |
| | [illegible] | 2 | 660,000 | 126 | 304 |
| | | 3 | 590,000 | 110 | 216 |
| | | 4 | 560,000 | 106 | 180 |
| F | [illegible] | 1 | 420,000 | 71 | 198 |
| | [illegible] | 2 | 335,000 | 70 | 136 |
| | [illegible] | 3 | 300,000 | 63 | 94 |
| | | 4 | 295,000 | 60 | 84 |
| G | [illegible] | 1 | 235,000 | 57 | 108 |
| | [illegible] | 2 | 220,000 | 56 | 86 |
| | [illegible] | 3 | 215,000 | 50 | 66 |
| | | 4 | 200,000 | 50 | 53 |
| H | [illegible] | 1 | 375,000 | 71 | 175 |
| | [illegible] | 2 | 310,000 | 70 | 125 |
| | | 3 | 275,000 | 63 | 83 |
| | | 4 | 255,000 | 60 | 69 |
| I | [illegible] | 1 | 220,000 | 61 | 99 |
| | [illegible] | 2 | 195,000 | 60 | 76 |
| | | 3 | 195,000 | 53 | 58 |
| | | 4 | 190,000 | 47 | 52 |
| J | Configuration and capacity with both runways intersecting | 1 | 465,000 | 87 | 217 |
| | | 2 | 430,000 | 87 | 167 |
| | | 3 | 290,000 | 87 | 118 |
| | | 4 | 365,000 | 81 | 99 |

Source: [illegible] Planning, FAA Advisory

the airport is to serve will help to determine how much additional capacity will be required at the airport. Four distinct elements require investigation, namely:- the airfield, the terminal area, the air space, and surface access. The maximum capacity achievable will depend on the capacity limitations in any of the four elements.

After determining the airfield, terminal area and airspace capacity, the forecasted demand is imposed on the system, and the additional capacity required for the master plan airport is determined.

5.81 Air-field Capacity :

Airfield capacity is the rate of aircraft movements on the runway/taxiway system which results in a given level of delay. The current methodology used by the American Federal Aviation Authority (FAA), considers that capacity is reached when delays to departures average four minutes during two adjacent normal peak hours of the week for large transport type aircraft operations. For general aviation type operations with small aircraft, the average delay level is two minutes for the peak hour of the week.

5.82 Terminal Area Capacity:

After preliminary calculations of the airfield capacity requirements have been made, it is neccessary to determine the the capacity requirements of the terminal area. Within the terminal, area, indivisual elements should also be analysed to keep the terminal area system in balance .

In comparing the terminal area capacity, it is necessary to use common demand terminology. Thus, the airfield capacity must be translated into numbers of passengers and tons of cargo, in order to express the capacities in equivalent terms.

Terminal elements to be included in theanalysis are:-

(1) Air-line gate positions.

(2) Air-line apron areas.

(3) Cargo apron areas.

(4) General aviation apron areas.

(5) Air-line passenger terminals.

(6) General airation terminals.

(7) Cargo building.

(8) Auto parking.

(9) Aircraft maintenance facilities.

5.83 Airspace Capacity:

The proximity of airports to oneanother, the relationship of runway alignments, and the nature of operation (IFR and VFR) are the principal inter-airport consideration which will affect the capacity of the airport under planning.

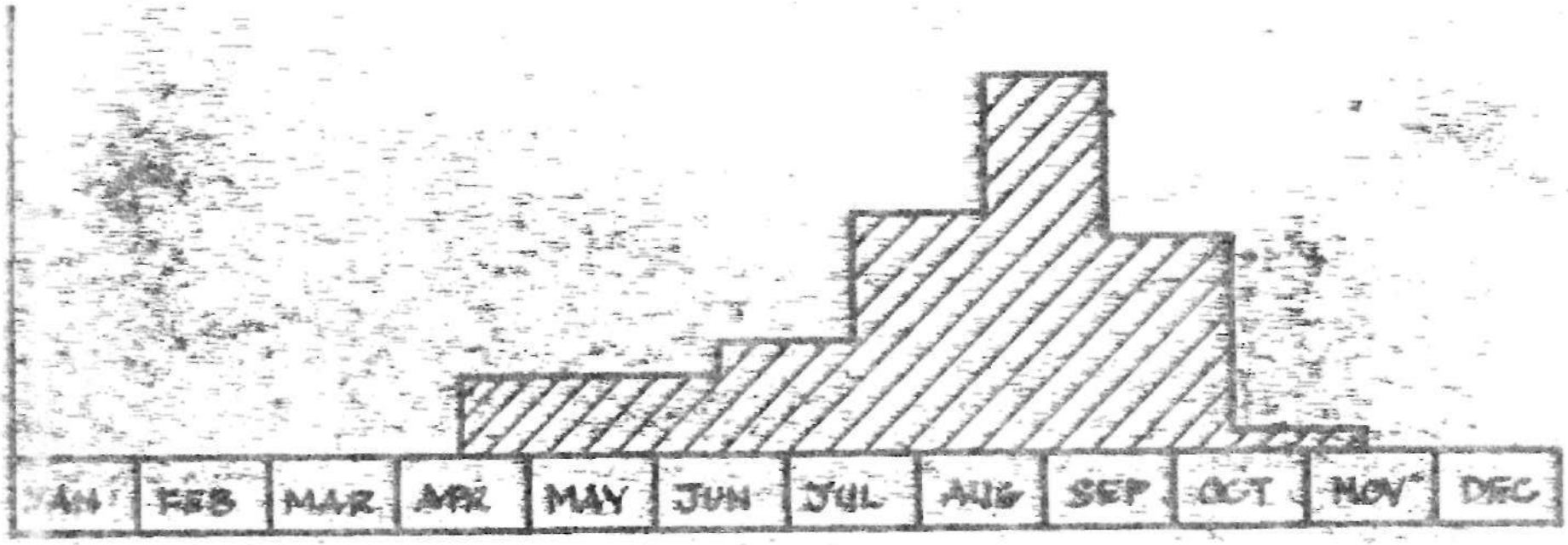
5.84 Airport Access Capacity:

The establishment of capacity requirements for the Master Plan airport will determine the capacity required for airport access. The airport capacity figures should be translated into numbers of movements by people and access vehicles. A preliminary examination of existing and planned highway and mass transit systems should allow a judgement as to the availability of surface access capacity.

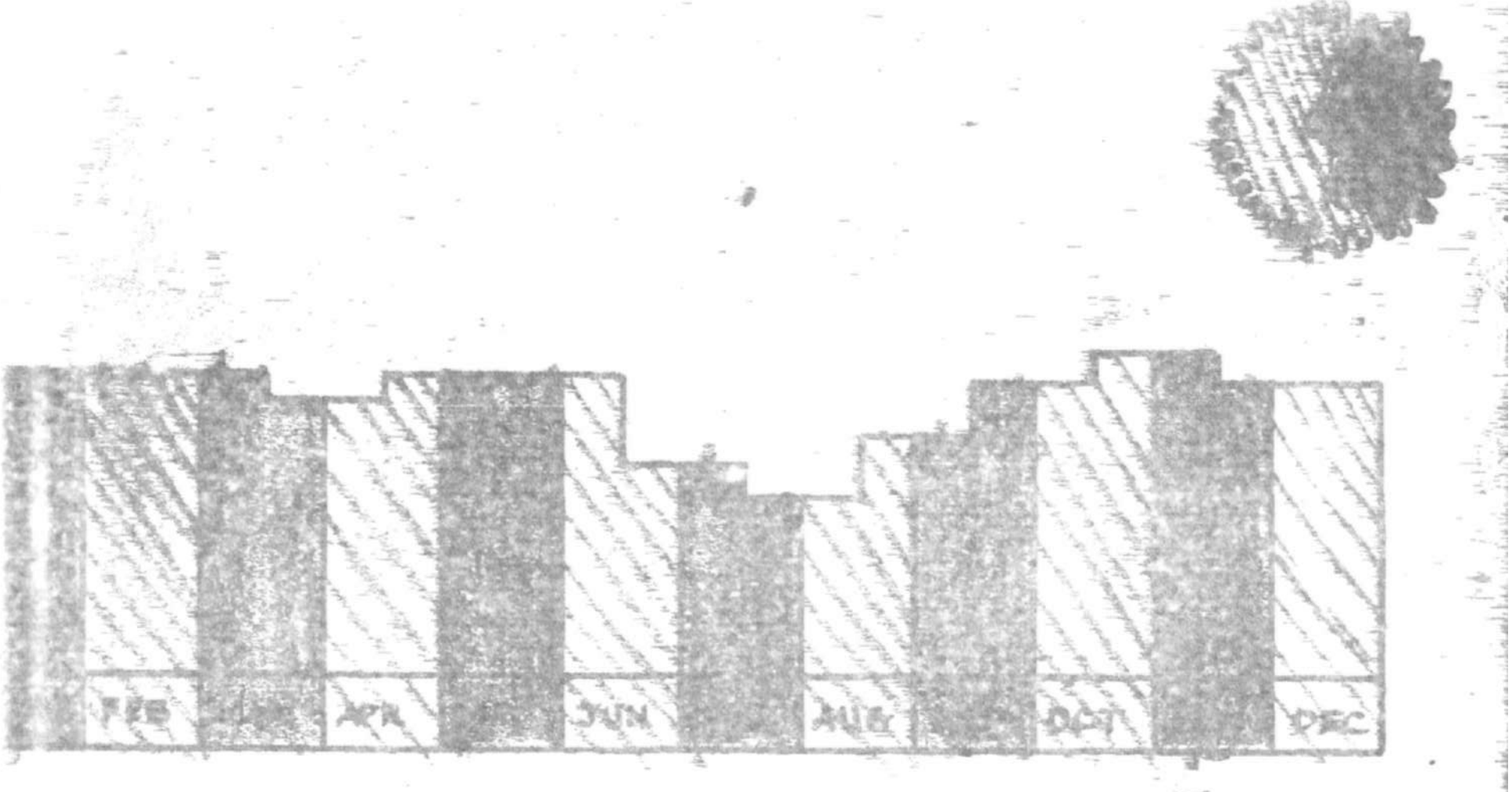
In determining the volume of people it is necessary to establish the percentage relationship between passengers, visitor and airport employees. Also the potential of mass transit as a principal consideration should be examined.

5.05 Air Traffic Control and Navaid Requirements:

Demand/Capacity analysis provides insight in terms of the type and timing of air traffic control facilities and air navagation aids that will be needed at the Master Plan airport. The extent of airspace available, the volume of traffic projected and thenature of operations (IFR and VFR), that could be expected are the determining factors.




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E RAGE SUNSHINE HOURS - [MONTHLY] - KANO



The Tudun Wada area is inhabited by other moslem Nigerians with the same values as those in thecity.

The heterogenous settlement of Sabon Gari islike the Nigerian tribes isrepresented. Both Christians and Moslems are found. This area is both thecommercial and social hub of Kano. Shops abound and night-clubs are aplenty.

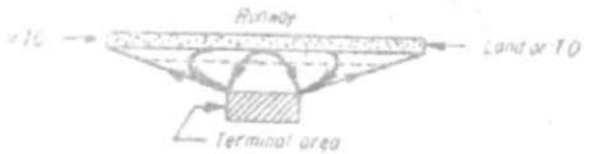
The G.R.A. (Nassarawa) was formerly the area reserved for the colonialist but with self government taken over by elitist Nigerians and Foreigners. The houses are usually well designed and landscaped.

6.23 Site Analysis:

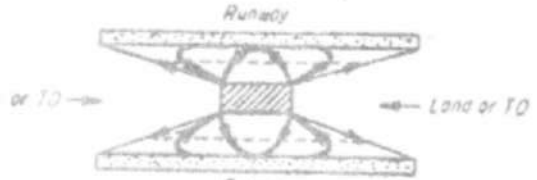
The site is outside thecity and beyond Sabon-Gari . The approach and take off, paths are free from vertical obstruci on. The settlements around the airport are low density huts dotted on farmlands. The nearby populations in the farming villages of Gama Kwari andRafin Mallam should be discouraged if an increase in population donsity isenvisaged. Ownership of farmlands can be allowed and relocation of buildings to Tudun Wada or Ungogo village considered. Thisisto avoid any future litigations due to exposure to undesirable noise-levels. The U.D.B. should work-out a compatible land-use in the immediate vincinity of the airport.

Adequate additional land has been acquired and compensated for. I dentification of the airport from the air to made easy by the River Jakara on the North-East andthe Dala hill from the South. The Jakara River runs on the Eastern end of the plot and does not so much limit expansion possibilities.

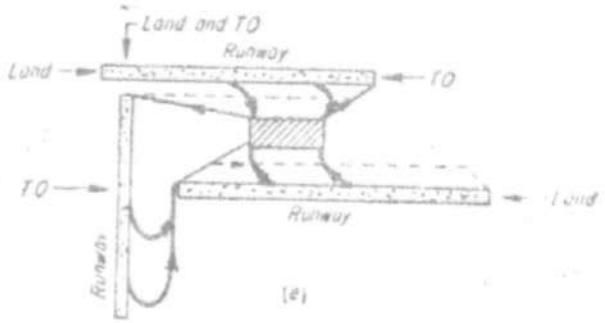
Power, telephone and water services are available.




(a)

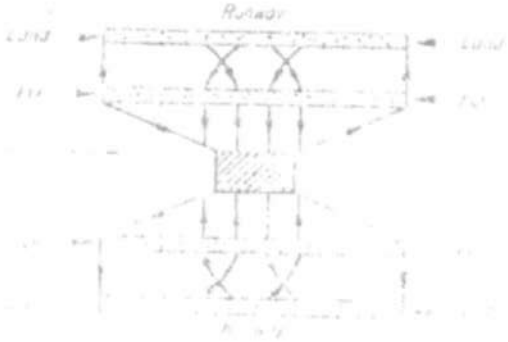



(b)




(c)






RELATIONSHIP OF TERMINAL TO RUNWAY

## 6.30 DETERMINATION OF PEAK HOUR PASSENGERS AND NUMBER OF AIRCRAFT GATE POSITIONS.

### 6.31 Peak Hour Passengers:

There are two methods of determining thepeak hour passenger flow:- The Port of New York Authority mode and The Birmingham Airport model.

(a) Port of New York Authority Model

The model uses thefollowing method to compute the;peak hour flow:

Average monthly passengers = 0.08417 x annual passenger flow.

Average daily passengers = 0.03226 x average monthly flow.

Peak day flow = 1.26 x average daily flow.

Peak hour flow = 0.0917 x peak daily flow.

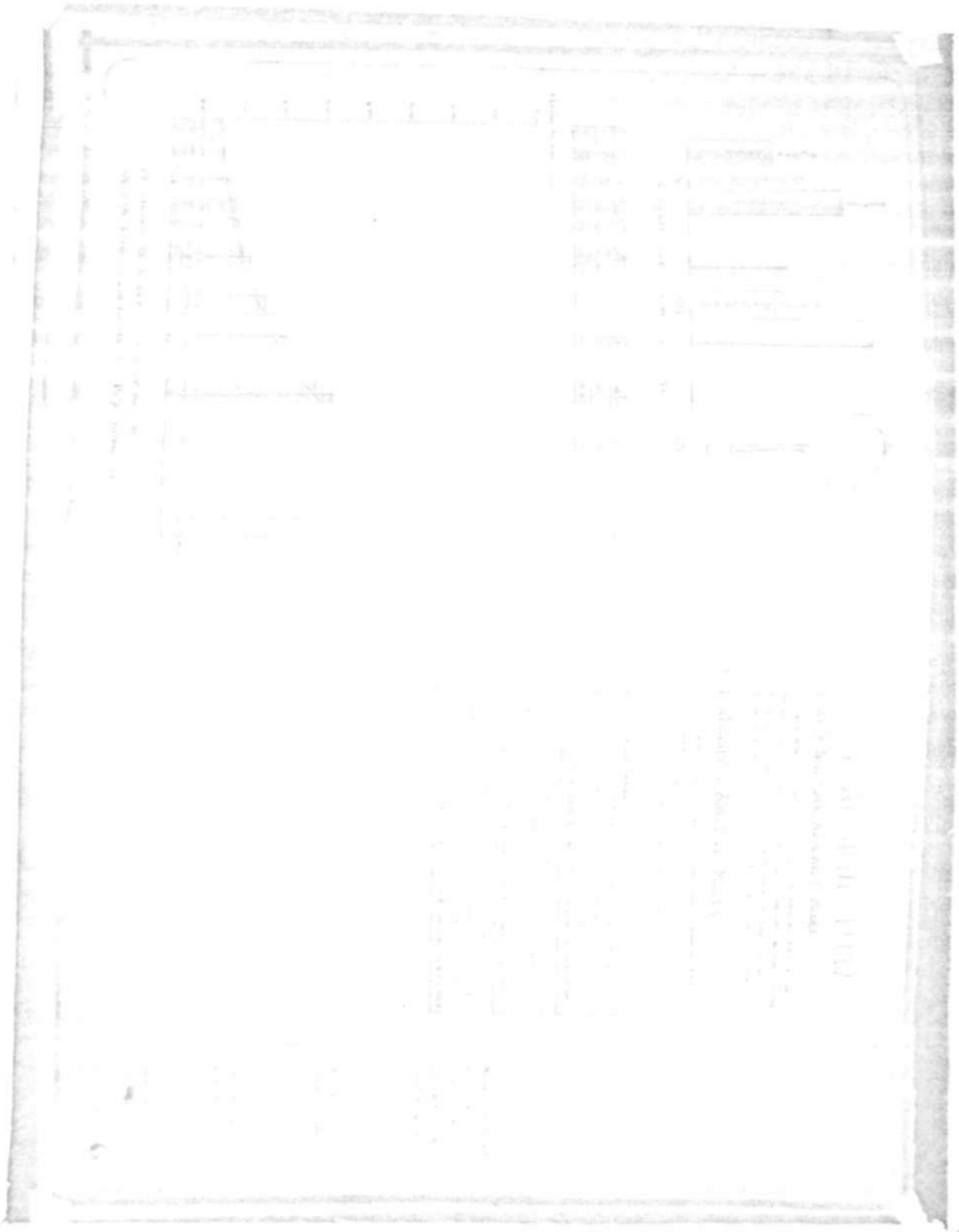
The peak hour passenger flows are converted into peak aircraft flows using estimates of average passenger load per aircraft computed from projected load factors and projected seatings per aircraft movement.

(b) Birmingham Airport Model.

This model computes the standard busy rate (SBR), the thirtieth busiest hourof the year. The logistic projection of the SBR coefficient isused, and defined thus:

$$\text{SBR Coefficient} = \frac{\text{SBR}}{\text{Annual Terminal Passengers}}$$

The estimate of the design SBR was obtained by muttiplying the estimate of the SBR coefficient for the design year by the estimate annual number of passengers.



In the case of Kano, there isno record of a standard busy rate, so the port ofNew York Authority will be used to compute the peak hour passenger which will reflect in the schedule of accomodation. Thus using the first model:-

| | |
|---|---|
| Phase I | AV. Monthly Pax =.0.08417 x 1m = 86,417<br>AV. Daily Pax = 0.03226 x 86,417 =. 2,788<br>Peak Day Flow = 1.26 x 2,788 = 3,513 Pax<br>Peak Hour Flow = 0.0917 x 3,513 = 322 Pax |
| Phase II | AV. Monthly Pax = 0.0817 x 3m = 252,510<br>AV. Daily Pax = 0.3226 x 252,510 = 8,146<br>Peak Day Flow = 1.26 x 8,146 = 10,264 Pax.<br>Peak Hour Flow = 0.0917 x 10,264 = 941 Pax. |
| Phase III | AV. Monthly Pas =.0.0817 x 6m = 505,020<br>AV. Daily Pax = 0.3226 x 505,020 = 16,292<br>Peak Day Flow = 1.26 x 16,292 = 20,528 Pax.<br>Peak Hour Flow = 0.0917 x 20,528 = 1,882 Pax |

6.32 Determination of Number of Aircraft Gates:

The term "gate" designates an aircraft parking space adjacent to a terminal building and used by a single aircraft for the loading and unloading of passengers, baggage and mail.

The final configuration of the airside interface depends largely on the number of aircraft gates. First principles would lead the designer to the conclusion that the number of gates is function of the design peak hour aircraft movements, the length of time that the indivisual aircraft spend at the gates and some utilization factor to account for the impossibility of filling all gates for 100% of the peak time because of maneuvering andtaxiing.

A formula by Horonjeff for computing the required number of gates (n) is given thus:

$$N = \frac{Vt}{U}$$

where V = design volume for arrivals or departures (aircraft/hour)

t = weighted mean stand occupancy (hr)

u = utilization factor, suggested to be 0.6 to 0.8 where gates are shared.

The weighted mean stand occupancy time for the Jumbo B-747 and DC-10 is one hour.

The peak hour passenger for each module is 1,000 and this will give us four aircraft arrival or departure per hour. Assuming a ittilization factor of 0.8 we thus calculate the number of gates.

$$n = \frac{Vt}{u}$$

$$n = \frac{4 \times 1}{0.8} = 5 \text{ gate positions.}$$

6.40 Design Brief and Schedule of Accommodation:

6.41 Design Brief:

An international airport with an annual passenger flow of six million is to be designed making provision for expansion. The design is to be phased so as to achieve adiscounted cost on the initial capital lay-out. It is desived the the building should have some reflection of traditional Hausa Architectural forms without compromising the international nature of such a project.

The project is to achieve the objective of provision of the following:- passenger comfort, minimum walking distance, operational efficiency and above all aesthetics.

6.42 Schedule of Accommodation:

The schedule of accomadation given below is for a typical module with a peak hour flow of 1,000 passengers.

| | Space Required Per 1,000 - TPHP($M^2$) FAA Standards |
|---|---|
| Domestic Terminal Space Facility | |
| Tickect Lobby | 1,000.00 |
| Airline Operational | 4,800.00 |
| Baggage Claim | 1,000.00 |
| Waiting Rooms | 1,800.00 |
| Eating Facilities | 1,600.00 |
| Kitchen and Storage | 1,600.00 |
| Other Concessions | 500.00 |
| Toilets | 300.00 |
| Circulation, Mech & Maintenance, Walls | 11,600.00 |
| Total:- | 24,200.00 |
| International Terminal Space Facility | |
| Public Health | 1;500.00 |
| Immigration & Customs & Plant Quarantine | 4,500.00 |
| Visitor Waiting Rooms | 1,500.00 |
| Circulation, Baggage, Utiuties, Walls | 7,500.00 |
| Total: | 15,000.00 |
| TOTAL GROSS AREA (DOMESTIC) | 25,000.00 |
| TOTAL GROSS AREA (INTERNATIONAL) | 30,000.00 |

Chapter Seven

# THE DESIGN REPORT

## 7.10 The Planning:

I In the first instance, the planning was aimed at simplicity; but a simplicity with an identity - not just another lazy rectangular box solution. The terminal building was concieved in planning as a funnel for channelling and proceessing passengers from landside to airside and in therevevse order as well. Distinction has to be effected for departing passengers who are being assembled and arriving passengers who are fanning out. Thisdistinction was achieved through a separation oflevels:- I departures on the1 1st floor and arrivals on theground floor, separation for domestic and international passengers was achieved by having the domestic wing on theright and the international wing by theleft.

## 7.20 Passenger Circulation and Separation:

### 7.21 Departures:

The passenger comes by the surface access modes - taxi, private vehicle or bus and goes up a ramp to the departures level on the first floor, where he is dropped at the landside curb. The terminal building isentered into from theseveral automatic door ingress system, where-upon a row of check-in counters face him. Here theticket is presented for a boarding pass and the load handed over for weighing and labelling upon which it finds its way independently of thepassenger to the aircraft.

After checking-in, the passenger just walks across to the control point where immigrations, port health and customs formalities are observed. After these formalities, thepassenger enters into the "No Man's Land" where you have duty free shops, arts and craft shops, conveniences, and seats. In this zone there are two sets

of stairs, leading to the mezamine level, one on theright leading to therestaurant and bar facilities for those who have enough time to spare, and one on theleft where the first class waiting facilities are located.

Beyondthis general waiting area there are five hold-rooms for thefive different gates. When the flight and corresponding boarding gate is announced, all passengers on that flight assemble in thehold room for the particular gate, where oneby one they go through final security-check consisting ofthemetal-detecting arch and X-ray monitor for hand luggages. Immediately beyond the final security check you enter thegangway leading to the telescoping arm and thence into the aircraft and then await final take-off.

7.22 Arrivals:

Upon landing and maneuvering of the aircraft to the assigned gate position andproper hook up to thetelescoping arm, the passenger disembarks by walking through thearm then to the gang way and finally to thearrival gallery on thefirst floor. A transit passenger will go through thehold room to thegeneral waiting area where he obtains information about hisnext flight. From the arrival gallery on the first floor, the passenger takes any of the set of escalators conveniently placed down to thearrivals hold room on theground floor (i.e. arrivals level). There are two arrivals hold rooms, where arrivals formalities like passport control, and port health take place. For faster proceessing two lines are allocated for Foreigners, and one each to thefollowing nationalities - Nigerians, Ecowas countries and others.

Both hold rooms lead to a central baggage claim area where there are three racetrack type baggage retrieval system. After

picking his baggage, thepassenger goes through the custom control points. There are three ofsuch points with each having a "green " and a red "channel." The "green" channel is for those with nothing to declare and the"red" channel for those with something to declare.

Beyond thecustoms, thepassenger reaches the baggage identification control and beyond it to the general arrival hall where thepassenger meets hisrelatives who have come to pick him up, or else goes for the row of desks assigned to hotel reservations, rentacar, banks, Post Office etc.

Comfortable seating arrangement and conveniences like W.Cs, restaurants, bars, telephones etc. are located at the arrival hall for the convenience of relatives awaiting the arrival of their kins.

Egress from the terminal building is effected through a set of conveniently located automatic doors system to thecurb where the passenger takes his private auto, faxi, bus, or rent-a-car and finally executing his exit from theairport complex to his final destination at home or at a hotel.

7.30 Baggage Circulation and Separation:

7.31 Derartures Baggage:

The passenger separates with his baggage upon handing over to the check-in clerk for weighing and assessment. After weighing, the clerk places the baggage on to a secondary conveyor belt which takes thebaggage to theprimary conveyor belt and finally to thebaggage make-up area on the ground floor where the baggages are made up into containers or igloos for the respective flights and destinations. This container or igloos are placed

on trolleys which are then hooked-up to a tug which then takes the baggages to the designated aircraft where it is loaded into the cargo hold of the aircraft.

7.32 Arrivals Baggage:

The baggages in theform of containers or igloos are removed from the aircraft cargo-hold on to trolleys which are then hooked up to a tug for delivery at the central baggage break-up area. From here, the igloos are openedt-up and the baggages are then placed one by one onto to the race-track baggage retrieval systems which reaches the central baggage clain area where the passengers pick up their respective baggage.

7.40 The Structure:

The first row of columns on the landside-approach are on a line forming part of a circle with the radius of 97 metres from the centres of which the columns radiate at an angle of to meet another row of columns 30 metres beyond. This portion is covered by a set of radiating shells tilted so that the roof is visible on the approach side.

A part of a slightly more than a half dome springs up beyond the 30 metres covered by shells. The dome has a radius of 27 metres and arise of 8 metres to dominate the elevations. At the 27 metres radius ther are a set of fat circular columns to transfer the load from the part dome to the ground. From this circular columns radiate another set of shells at $16.5^{0}$ to span 60m. There are columns at 30m to shorten the load span.

7.50 The Services:

The whole complex is airconditioned using low velocity conventional system. The central air-condition system is placed on the roof. The ducts follow the structural beams where you have intake and supply ducts. The objective is to have a sixty percent air change environment as this is the most suitable coefficient for such crowd gathering complex.

7.60 Vehicular Movement and Parking:

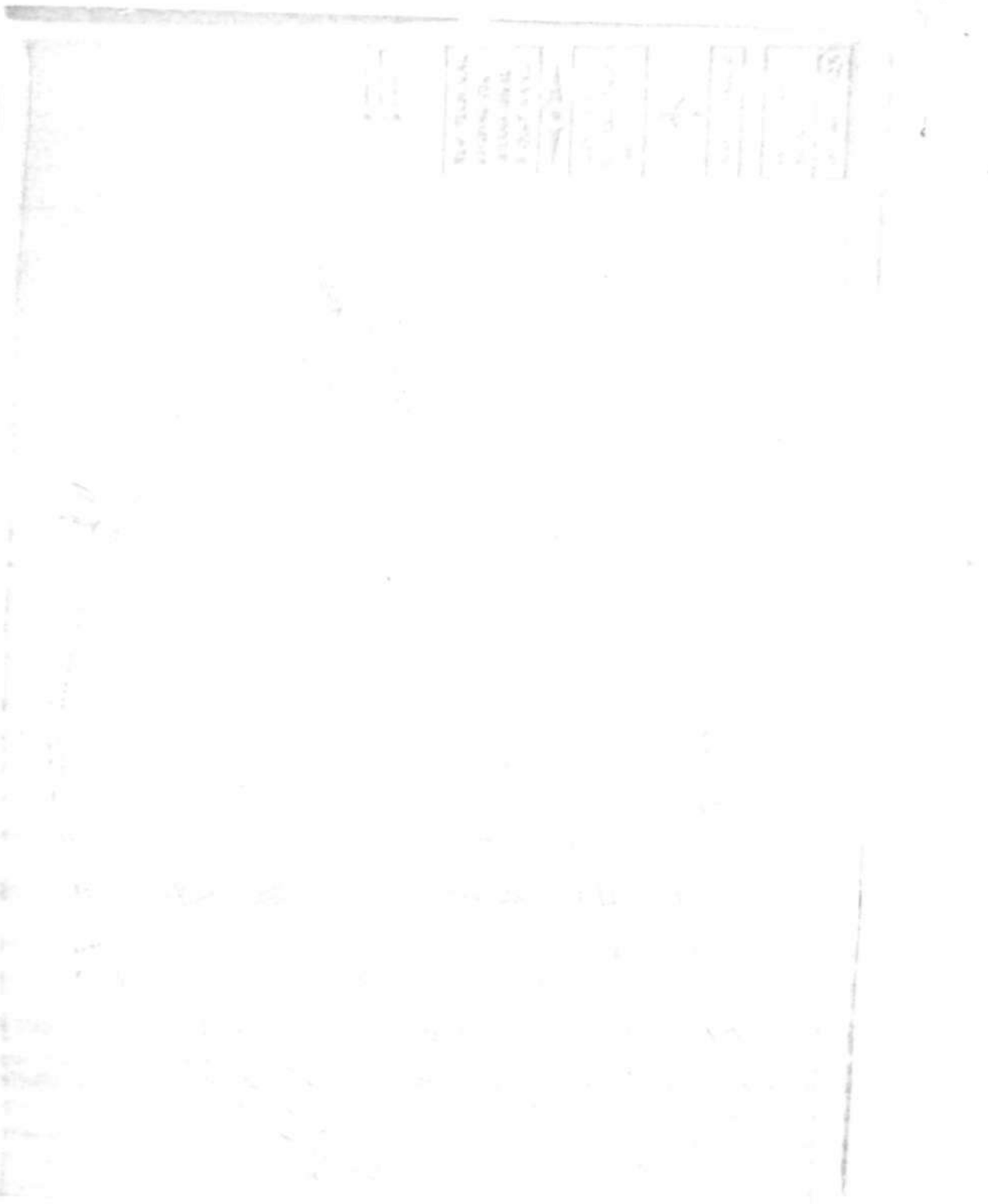
Vehicles go up a ramp to the departures level where departing passengers are dropped off. The vehicle continues on the ramp until it reaches the "come-down" ramp to theparking area.

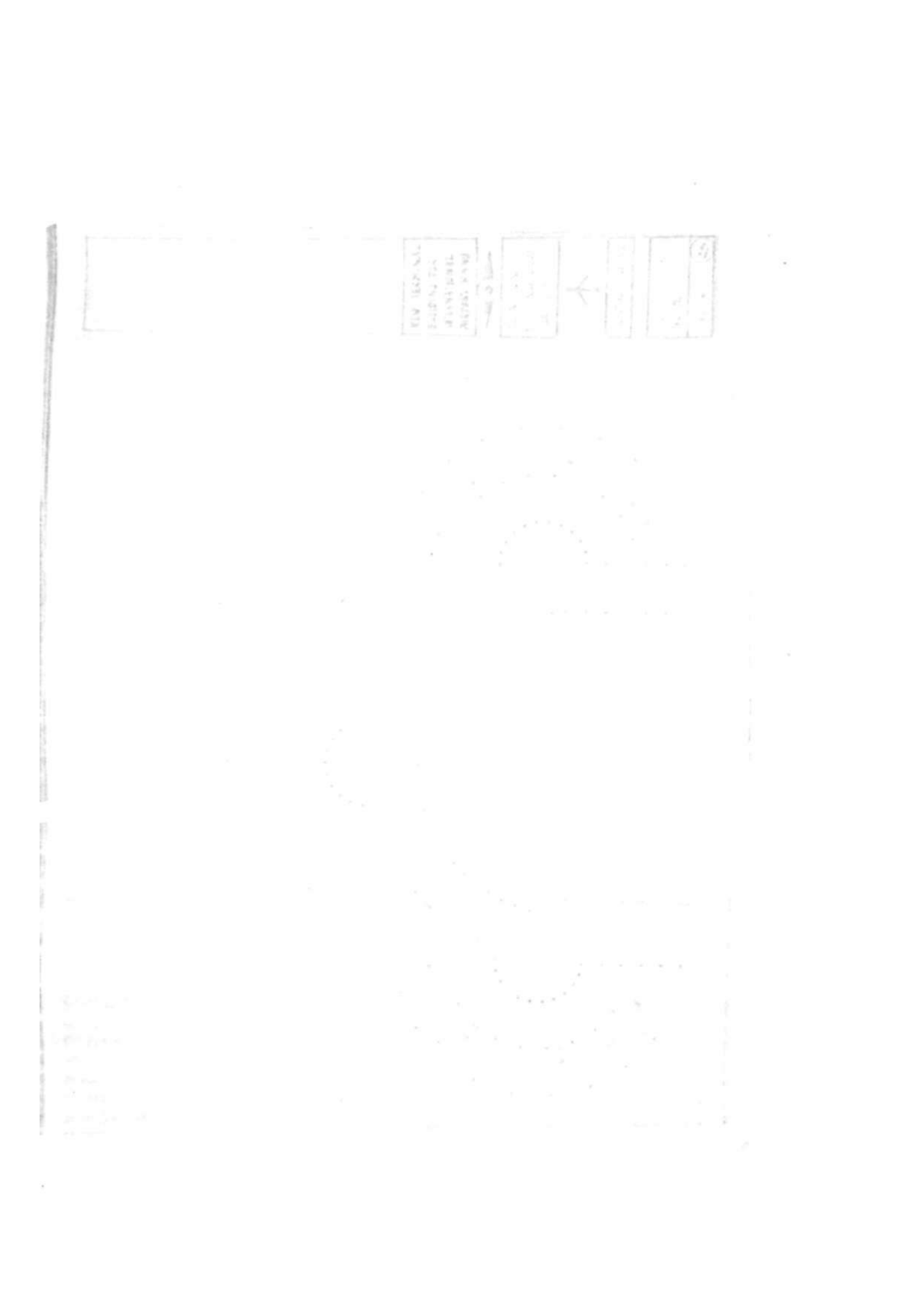
There are parking areas for long term, short term, taxi and buses, airline workers and airport workers.

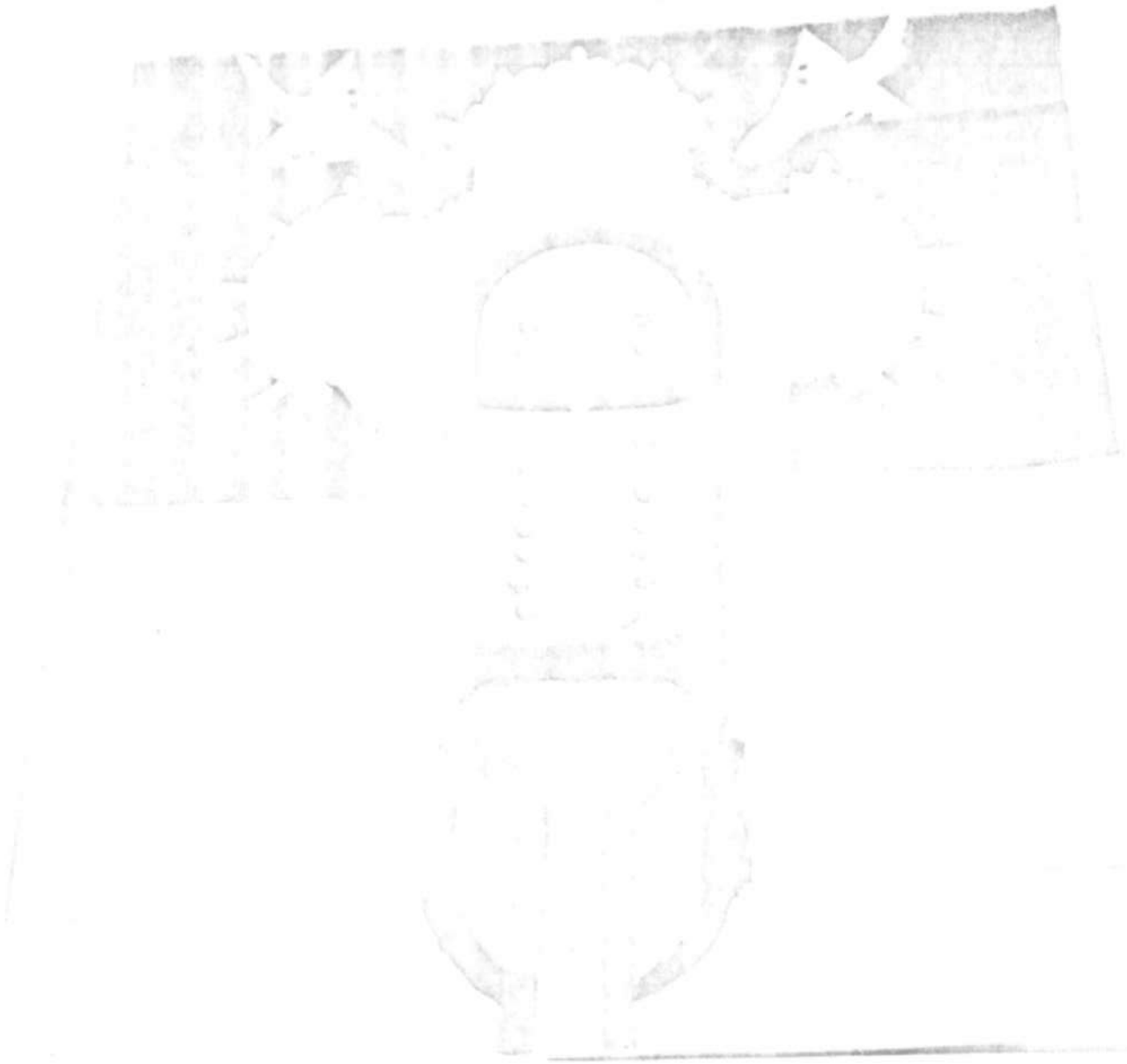
On the ground floor there is a network of roads to the parking areas. The ramp conviently joins the road below to form the airport access system.

7.70 Expansion:

The terminal is based on a module capable of an annual passenger volume of two million. Expansion is by just simply repeating this basic module. There is a possibility of four such modules to take care of eight million annual passenger volume.









# A P P E N D I X

## B I B L I O G R A P H Y

A.I.A. Journal - November, 1980 pp. 46 - 51.

"Airport Engineering" - Ashford and Wright.

"Airports for the 80's" - Proceedings of the 4th World Airports Conference 3rd - 5th April, 1973.

"Airport Management Handbook" - F. A. A.

"Airport - Master Plans" - F. A. A.

"AJ Metric" - Architectural Journal.

"Architects' Data" - Neufert

"Modern Architecture - A Critical History" - Frampton, K.

"Planning an Airport in a Developing Country" - Paper I.A.A.I.

"Planning and Design of Airports" - Horonjeff, R.

"The Flier's Handbook" - Editor Varley, H. Pan Books.

"Time Saver Standards - Building Types" - Chandlier and De-Chiara.