SOFT DRINKS FACTORY FOR ZARIA

By

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PEOPLE DON'T PLAN TO FAIL

THEY ONLY FAIL TO PLAN

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ABSTRACT STATEMENTS

This thesis is intended to investigate and explore the various architectural problems and processes involved in soft drinks production and to provide some suitable solutions. Basically, the programme is aimed at covering up the design of a soft drink factory for the production of soft drinks of different varieties to be sited at the light Industrial Area of Zaria.

The choice of Zaria as a site for locating the factory is not accidental. All necessary facilities needed for such an industry, such as, good roads, railways and rail siding are available and this will enhanced quick transportation of both starting materials and the final products.

The principal starting materials are water (treated water), sugar, carbondioxide and concentrates which are abundant in the Country, except the concentrates which could be imported from outside.

Considering the rate of unemployment in the Country, the potentials of soft drinks production and the obvious needs for a system of distribution to the ever increasing demand, the important role which an industry of this nature will play in providing employment and distribution system for soft drinks in the country needs not be over

emphasised. Furthermore, a soft drinks factory could be viewed as a comfortable and fairly humane, environment for the factory workers.

It will be wrong for one to view a bottling industry as just an enclosure to house machines only. More care should be spent on the factory interiors than is often spent on the office accomodation.

The aim is to treat the factory as a whole, as an object of architectural beauty, the fruit of creative thought. As the 1980's is seen as an industrial development era in the Country and being a Nigerian, I am of the opinion that this project will expose me to the problems of industrial design generally and that of bottling industry in particular, thus, enabling me contribute my quota to the industrial development of the nation.

D E D I C A T I O N

This piece of work is dedicated to Allah, for keeping me in good health and positive tempo.

To my parents who have through their love and co-operation brought me to this status.

To my brothers and sisters whom I have set the ball rolling.

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

In a thesis of this nature, where case-studies and data collections are essential in-order to fulfil the design goals and objectives, one build enormous debts. The writer would like to record his sincere thanks to the following bottling Industries for generously providing relevant information and so kindly allowing their factories and products to be described and criticised:

The Nigerian Bottling Company Limited, Kaduna.

Drinco Industries Limited, Brahma Soft Drinks Bottler, Kaduna.

Arewa Bottlers, Kaduna, The makers of PEPSI-COLA and MIRINDA.

The writer would also like to express his gratitude to those individual - Organisations, Institutions and Local Government Authorities whose tremendous contributions made it possible for the compilation of this thesis.

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Hajiya Aminatu A. Saidu - His Wife.

Hajiya Maimunatu A. Saidu - His Second Wife.

and Mallam Bello Tukur - My Brother.

Finally, may the reader find further pleasure and satisfaction in all his future studies work.

ABSTRACT STATEMENTS

This thesis is intended to investigate and explore the various architectural problems and processes involved in soft drinks production and to provide some suitable solutions. Basically, the programme is aimed at covering up the design of a soft drink factory for the production of soft drinks of different varieties to be sited at the light Industrial Area of Zaria.

The choice of Zaria as a site for locating the factory is not accidental. All necessary facilities needed for such an industry, such as, good roads, railways and rail siding are available and this will enhanced quick transportation of both starting materials and the final products.

The principal starting materials are water (treated water), sugar, carbondioxide and concentrates which are abundant in the Country, except the concentrates which could be imported from outside.

Considering the rate of unemployment in the Country, the potentials of soft drinks production and the obvious needs for a system of distribution to the ever increasing demand, the important role which an industry of this nature will play in providing employment and distribution system for soft drinks in the country needs not be over

emphasised. Furthermore, a soft drinks factory could be viewed as a comfortable and fairly humane, environment for the factory workers.

It will be wrong for one to view a bottling industry as just an enclosure to house machines only. More care should be spent on the factory interiors than is often spent on the office accomodation.

The aim is to treat the factory as a whole, as an object of potential beauty, the fruit of creative thought. As the 1980's is seen as an industrial development era in the Country and being a Nigerian, I am of the opinion that this project will expose me to the problems of industrial design generally and that of bottling industry in particular, thus, enabling me contribute my quota to the industrial development of the nation.

I N T R O D U C T I O N

GENERAL

The basic requirement of all industries, is proper zoning and general circulation of the various activities that takes place within the created environment, such that efficient system of flow of all activities is achieved.

The production flow from raw materials or starting materials to final products should receive fairly more attention. Coherent Workable Machinery is essential. Proper Vehicular and Pedestrian Movements is highly essential in all bottling Industries.

In a bottling Industry, high degree of cleanliness and proper sanitation is required which results in hygenic system of production. The products must be fit for human consumption. The preparation of both light and final syrup, crowning, and washing of both empty bottles and crates are very essential things that need proper considerations.

The planning of a soft drinks factory should be, such that the prevailing Wind or Harmattan does not affect the main production hall. The architect should note this point seriously, because most of the production halls are usually semi-opened.

Water in bottling industries (soft drinks factories) is one of the essential raw materials or starting materials which could be available either from the municipal supply or bore-holes which could be drilled within the factory. This water is considered to be raw in bottling industries, hence, water treatment plant is essential to enhance the quality of the water. There are some specifications based on which the water is treated.

The need for soft drinks in Zaria and Nigeria as a whole, is increasing daily. In Kaduna alone, there are several soft drinks factories, but the main one are: The Nigerian Bottling Company Limited or Coca-Cola Bottling Company, Drinco Industries Limited - your Brahma Soft Drink Bottler, and Arewa Bottlers Limited, Kaduna, the makers of Pepsi-Cola and Mirinda.

The Coca-Cola Bottling Company produces about 800 bottles per minute. Brahma soft drinks bottler produces about 300 bottles per minutes. Pepsi-Cola has a production capacity of about 400 bottles per minutes. With these productions, still the demand for soft drinks is not met in and around Kaduna. In other words, One thousand five hundred bottlers of varieties of soft drinks are produced in every minute in Kaduna, yet not enough.

In Kano, the Coca-Cola bottling Company has a production capacity of about 6,000 bottles per minutes, Pepsi-Cola has about 12,000 bottles per minutes and Danta-Cola of about 6,000 Plastic Cans per minutes, still the demand has not been met in and around Kano. In view of this high demand, the existing bottling Companies in Kaduna planned to increase their production capacities. Coca-Cola in particular, is planning to put up another production line by July, 1983, Pepsi-Cola is trying to do the same. Brahma soft drinks bottler is planning to set-up another plant at Bauchi town in Bauchi State.

After Kano and Kaduna, Zaria could be considered as being the next densely populated area as well as an educational centre noted for its habitation of so many higher institutions of learning, with fairly educated and enlightened populace. Zaria does not have any soft drinks factory. The ones consumed by people of Zaria and its environs are mostly bought from Kaduna, Kano and Jos. So, one can say, without missing words that the consumption of soft drinks in Zaria and its environs alone, rivals favourably with each of the above mentioned towns, from which these products are brought from.

However, it is interesting to note that one bottling Company known as BALERE BOTTLING COMPANY has planned to put-up a soft drinks factory plant at Dakace Industrial Area of Zaria (along old Zaria-Jos Road). It has applied for a piece of land, and was approved by the Kaduna State Government. I hope, other bottling industries would do the same, so as to meet the increasing demand for soft drinks in Zaria and other catchment areas like Funtua, Saminaka, Ikara, Makarfi and Maigana.

CHAPTER - ONE

1.1 MOTIVES

In a thesis of this nature, where the student is left to decide entirely on his own, and to come out with a fairly reasonable topic, if care is not taken the student may run into trouble of choosing a suitable topic. The student must be aware of two or three constraints which are probably the worst enemies of anybody in thesis work.

(a) Time

(b) Source of Information.

The third factor is the SCOPE of the thesis. Apart from the above mentioned factors or constraints, the student should ensure that the topic he chose is at least interesting to himself and also that information is available within reach at all times.

I am dominated and motivated by these factors and some other values of the project as described below:-

Social Value of the Project

Unemployment is a problem to the Country generally, but in particular to some of the people of Zaria. With this project, this problem could be

fairly solved, by providing job opportunities to some of the people in Zaria.

Economical Value of the Project

The project has some potentialities of higher marketability not only accomodating customers but also vehicles bringing in raw materials and carrying out already finished products.

Series of soft drinks of different varieties would be produced principally according to a wholesale purchaser's order and individual sales or order. The project will offer relatively higher employment ratio to cost of investment. There is modest demand on energy and not too much expensive machinery equipments.

1.2 AIMS AND OBJECTIVES

The aims and objectives of this project are as follows:

(a) To provide more refreshments to the people of Zaria and its environs.

(b) To provide job opportunities to people of Zaria and its environs.

(c) It is a contribution towards technological improvement to the bottling industry in general, but particularly to the soft drinks factory.

(d) To improve the architecture of the area in which this factory is to be sited; that is, near Dogarawa Village along the new Zaria-Kano Road.

(e) To find solutions to some of the problems related to bottling industry.

(f) To emphasised on the need for proper architectural design of a much more comprehensive soft drinks factory.

1.3 SCOPE AND OUTLINE OF PROPOSALS

(a) ADMINISTRATION AND MANAGEMENT

i. Sales Department.

ii. Purchasing and Supply Department.

iii. Technical Department.

iv. Social/Welfare Department.

v. Accounts Department.

(b) MAIN PRODUCTION UNIT

i. Storage area for starting materials.

ii. Cold room.

iii. Concentrates store.

iv. Preparation of light syrup area.

v. Preparation of final syrup area.

vi. Quality Control Room/Laboratory.

vii. Offices for Production Supervisors/Others.

viii. Storage/Despatch Area for final product.

(c) WORKERS FACILITIES

i. Cafeteria

ii. Common room

iii. Changing area for production workers

iv. Washing area and toilets

v. Dispensary

yi. Store facilities

(d) AUXILLIARY UNITS

i. Carbon-dioxide (CO_2) Production Area

ii. Water treatment plant

iii. Ammonia compression plant

iv. Boiler House

v. Electrical/Mechanical Workshop

vi. Maintenance workshop and spare parts

AUXILLIARY UNITS (Contd.)

vii. Generator/Transformer House

viii. Water Reclamation Plant

ix. Water Storage Tanks

x. Gate House/Parking Facilities

xi. Bore-holes to supplement water supply from municipal supply.

.4 ECONOMY AND IMPLICATIONS OF THE PROJECT

The project offers relatively higher emplyment ratio relatively to cost of investment, because there is modest demand on energy and not too much expensive machinery equipments when compared to other heavy industries.

The project has potentialities of higher marketability in the near future in view of the favourable climatic conditions of Zaria. That means that, not only will it accomodate customers but also vehicles bringing raw materials to the factory and carrying already finished products too.

There should be individual sales or order with series of varieties of soft drinks to be produced principally according to wholesales purchaser's supply or order.

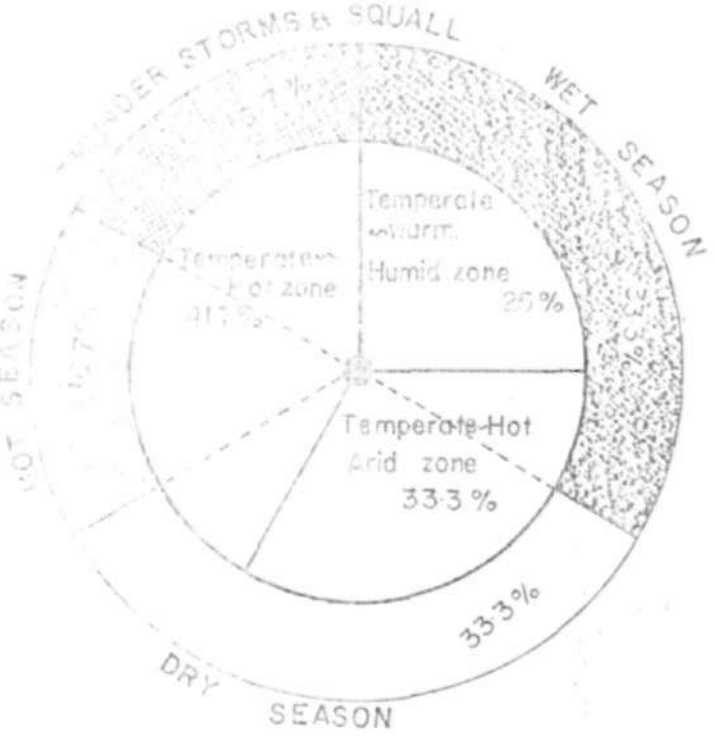
CHAPTER - TWO

2.1 LOCATION AND DISCRIPTION

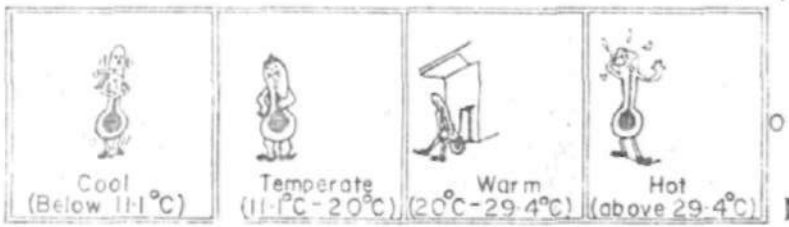
Industries however, small they may be, if not located at a well planned area within the master plan, will lead to urban decay, the desease that turned most advanced countries into hot beds of violence delapidation, over-crowding and very soon people will move to leave desolute areas. After taking care of this unhealthy situation, other factors that influence selection of a site for locating an industry are looked into. Some of these factors include:

- proximity to source of raw material.
- availability of suitable land with required acreage.
- availability of good road and other access facilities.
- availability of necessary industrial services and required labour.
- amiable climatic conditions.

The site of the proposed factory is located in the proposed Zaria Light Industrial Area as planned in the Land-use Map of Zaria Township. This area

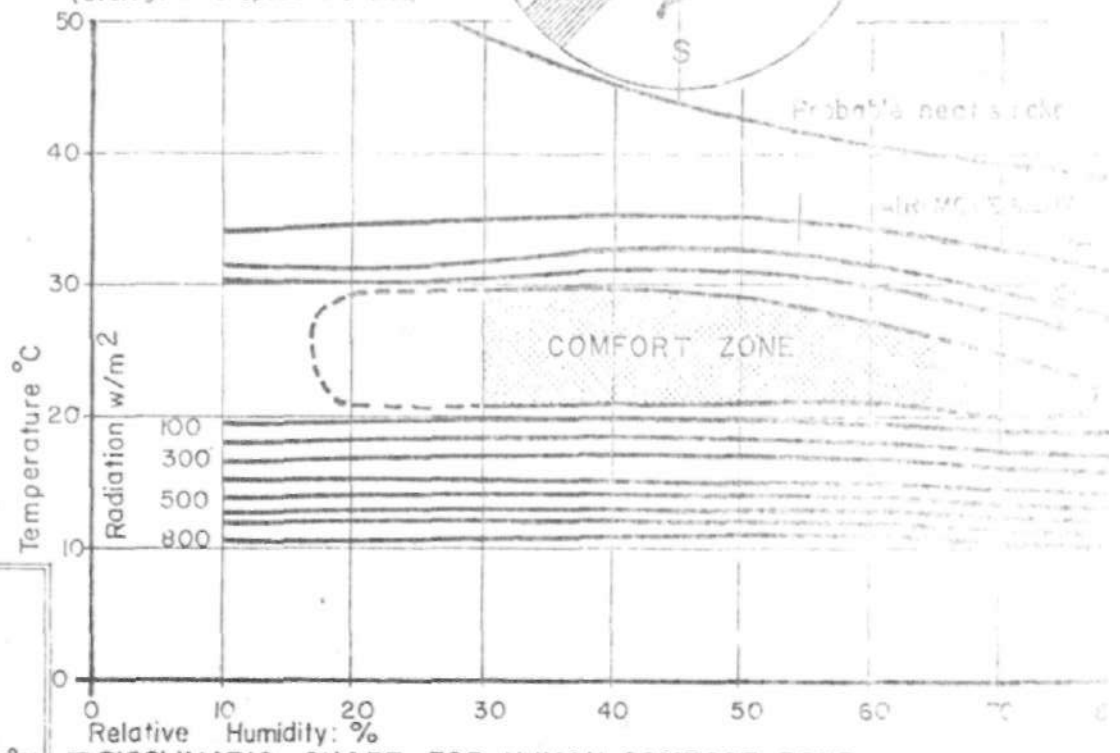


■ ANNUAL AVERAGE CLIMATIC CONDITIONS & CORRESPONDING SEASONS AT *SAMARU*



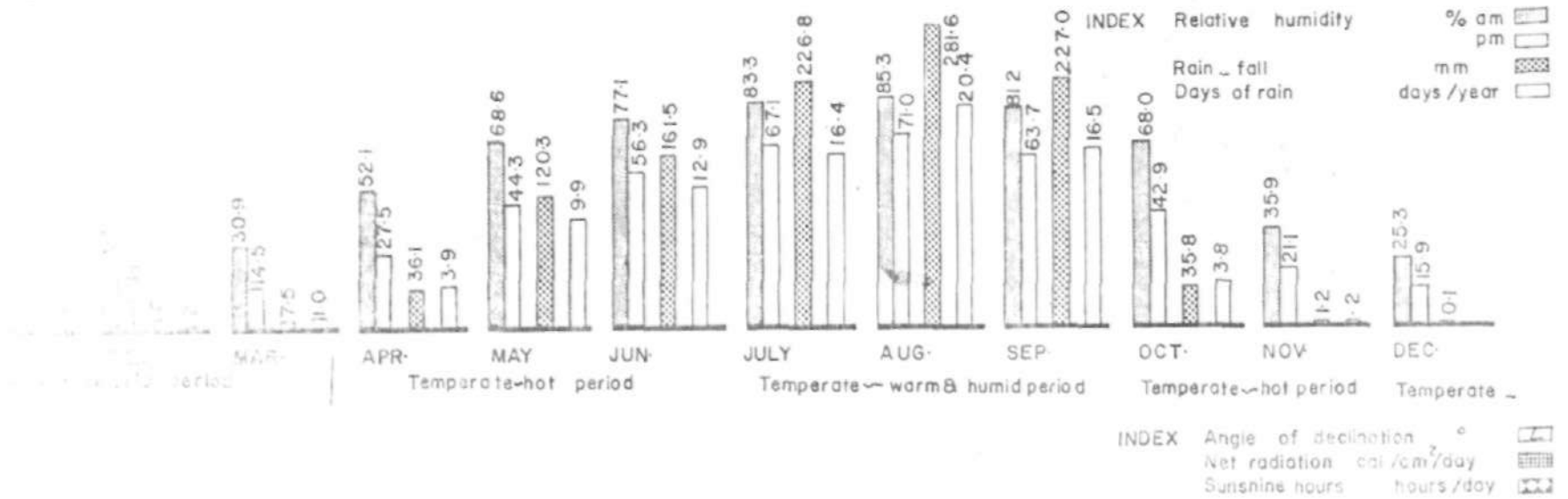
■ PREVAILING WIND DIRECTION & AVERAGE WIND SPEED, AT *SAMARU*

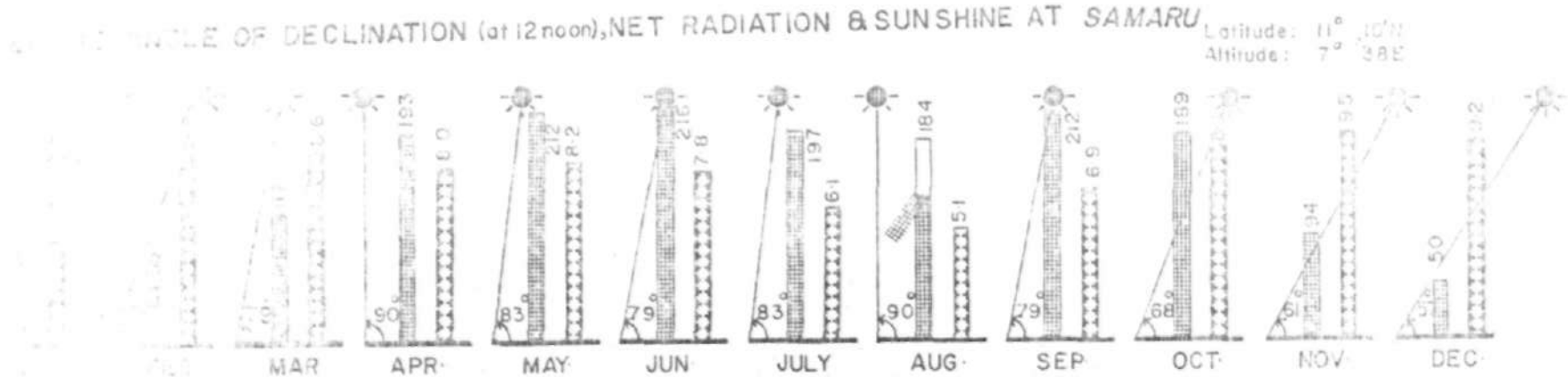




■ BIOCLIMATIC CHART FOR HUMAN COMFORT ZONE

FIGURE-6·5 CLIMATE





2.3 SITE ANALYSIS

Various factors have contributed to the choice of the site. Beside the suitable climatic conditions already refered to in the discussion above, there are also specific considerations that apply to this site in particular.

2.4 VIEWS AND VISTAS

The site has high potentials of good views with excellent vistas at least in three major directions which if fully utilised will not only provide the viable working environment for the workers but also a beautiful scenery for people to walk around. This will be of perticular importance for commercial and advertisement purposes.

2.5 SERVICES

This area is dominated by some industries as such most of the services meant for industrial use are already existing. To this end, services like power supply, railsiding, access road, water and telephone services can easily be tapped or improved for the use of the proposed factory.

The site has slope of about 4% which can serve as natural drainage coupled with the advantage of a small stream which now serves as a main drainage for the existing factories as well as waste disposal point.

2.6 ACCESSIBILITY

Access to the site has already been developed leading to the adjacent industries and to the small village over the banks of the stream. Moreover, the factory is sited close to the major access road to the industrial area so that it is clearly located and is straight forward for easy location. Another important aspects of the site is the fact that a good linkage could be made as already proposed in the new Land-use Map to the new Kano Road thereby making it easier to connect to anyother part of the country for distribution of finished products to customers.

Rail services are also very well developed for any goods transportation.

2.7 SITE IMPROVEMENT

Although the site sounds perfect, it has its short-comings and special attention was given to such areas.

PHOTO





Pedestrian Movements

Pedestrian access needs be developed as presently no separated pedestrian walk-ways exist rather, the vehicular access, also serves as the pedestrian access. It is therefore, necessary that a provision is made for the safety of the pedestrians. Along with this problems is that of access by lined buses and taxis. I have therefore proposed a bus stop to cater for taxis and buses that will convey some of the factory workers.

2.8 GEOLOGICAL HISTORY OF THE SITE

The site is largely underlain by some superficial deposits which include older and younger laterite and older and younger alluvium. The laterites are distinguished by a number of variables. Thus for example the older laterite are red-brown in colour, cellular, relatively free from impurities and up to 6.100m. thick. The younger ones are browner, less cellular, less free from impurities and rarely more than six feet thick.

The older aluvium deposits are of fine grey-brown sands, clays, re-sands and gravels of between 4.70 - 12.20m. thickness, while the younger alluvium consists of grey-brown sands, silts and clays

of up to 30 feet thick. The Harmattan winds annually deposit large quantities of dust which form part of the alluvial deposit.

2.9 TOPOGRAPHY AND RELIEF

Generally speaking, Zaria lies on the regional plains, of height ranging from 550 to 700 metres reflecting a general regional slope to the South and a local relative relief of 30 to 45 metres. The local slope angles are generally low - between $\frac{1}{2}^{o}$ to 4^{o} although in isolated areas they are quite steep. However, the proposed site in particular gullying occurs with high degree of frequency channel erosion and slope retreat on slopes which were produced through gentler erosion processes.

2.10 WATER SYSTEM

The major water requirements in Zaria and its environs are for domestic and municipal, industrial, irrigated agriculture, and livestock. The current demand estimates for the various categories of uses are at about 10million litres per day. The supply for consumption alone is estimated at about 25litres per person per day. The main sources of

water for human consumption and for animal and agricultural uses are rainfall and surface water. However, a considerable amount of ground water is known to exist in the area.

(a) Surface Water

Zaria area is part of an important water shed that divides the Sokoto and the Chad Basins. From the water-shed numerous rivers and streams flow out in a radial pattern and these includes the rivers Galma, Kubanni, Shika and others.

Two major dams have been built to meet the water demands for Zaria and its environs. The Zaria Dam, on the Galma River with a 16,000 million litres storage capacity reservoir and a dam on the Kubanni River with a capacity of 2,800 million litres to serve Ahmadu Bello University. The former could be utilised at the proposed site for the water supply.

(b) Ground Water

Although investigations on ground water conditions in Zaria area are incomplete, the ground water is known to exist under water

table conditions in both fractured and decomposed bedrock and in overlying bedrock. The ground water table contours tend to reflect land surface, ground water flows in all directions from highlands towards the stream but the water table and the Zone of saturation are interrupted by fresh bedrock out-crops.

CHAPTER - THREE

POPULATION AND COMMUNITY ANALYSIS

3.1 Projected Population

There were two sources that estimated the population of Zaria since the 1963 census. One was the Northern Nigerian Population Models prepared by NISER, relating to March, 1967. It estimated Zaria's population in March/April, 1967 at 211,740 and an estimated growth rate of 6.23% per annum after that date.

This projection, however, was found to be unrealistic, a projected population of 1.5 million in the year 2000 is really unrealistic population size for Zaria.

As a result of this development, the Department of Urban and Regional Planning, Ahmadu Bello University, Zaria, conducted a 10% sample housing survey of Zaria in July, 1975, which among other data, estimated the population of Zaria at 176,000. This projection, estimated the population of Zaria in the year 2000 to be 500,000.

For planning purposes a population size of 500,000 for Zaria in the year 2000 would take care

of growth strategy for Zaria in all aspects of developments, including government and private capital investiments, industrial location/expansion physical development, the further growth of educational institutions in Zaria and its environs.

It is important to note that the growth of population in Zaria is a function of Urbanisation process in the Northern part of the country. Thus, Kano - Zaria - Kaduna form a growth axis in this region. Typical of a town with large in-migrant population, Zaria has a very high proportion of young workers all needing jobs.

3.2 PEOPLE'S OCCUPATION

It is estimated that nearly 70% of Zaria's inhabitants 18years and above are engaged in some form of income producing activity.

3.3 OCCUPATIONAL STATUS

Full-time income producing occupations are of primarily two types; self-employed and wage employed. The self-employed sector or the regular labour force is estimated to be high up to 45% or about 44,000 workers. Wage employees constitute the remainder

of the regular labour force, excluding marginal and part-time workers.

The following list is a breakdown of wage-earning occupational classification

WAGE-EARNING CLASS	%
Sub-professional Staff	10
Senior Government Service	2
Clerical/Skilled Operative	35
Managerial	2
College/University Staff	3
Primary/Secondary Teacher	7
Semi-skilled/Apprentice	24
Driver/Mechanic	7
Labourer	10

This employment structure reflects the institutional service sector bias of Zaria's economic base.

As the self-employed sector of the labour force is substantial, it is worth examining a detailed breakdown of types under this general heading. Within this sector are the following broad categories:

SELF-EMPLOYED CLASS	%
Manager	2
Proprietor	11
Traditional Service and Craft	3

SELF-EMPLOYED CLASS (Contd.)	%
Modern Service and Craft	32
Market Trader	16
Small Scale Trader	31
Farmer	5

Those who are self-employed can be re-grouped into categories based on the non-agricultural economic base structure. Major Categories and the highest frequency occupational classes in each economic sector are reported as shown below:

ECONOMIC BASE CATEGORY	%
Retail	62
Commercial Service	27
Industrial Service	7
Crafts	4

Zaria's economic structure is characterised by a high labour force participation rate and a high ratio of self-employment in the service sector.

3.4 CIRCULATION

Four regional roads namely, Kaduna Road, Jos Road, Kano and Sokoto Road link Zaria Urban Area (ZUA) with the rest of the country. A 24 hour count of regional traffic and volume on these four

roads was conducted on 27th - 28th November, 1974. The following sub-sections high light the characteristic of this traffic.

3.5 VOLUME OF TRAFFIC

Considering the volume of traffic, Kaduna Road appears to be the most busy road where a total of 3872P.C.U. traffic passes in 24 hours. This is followed by Kano Road, Sokoto Road and Jos Road.

3.6 TRANSPORTATION

In the proposed Zaria Master Plan, prepared by the Urban and Regional Planning, Ahmadu Bello University, Zaria, it has been recommended that a truck terminus with parking facilities for idle trucks, loading, unloading and booking of goods and repair services be provided at a suitable site well accessible from the highways. It is also recommended to provide two or more loading, unloading sites at suitable locations near commercial, industrial and railway go downs. Apart from the above mentioned recommendations which is of great advantage, as far as this project is concerned, other services like Auto-service repair site, Bus

and Taxi stands, Inter-state Bus stands has also been recommended for the convinience of motorists. With these recommended facilities, the question of traffic bottle-neck which is likely to occur along New Kano Road is completely solved.

CHAPTER - FOUR

CASE STUDIES

In a thesis of this kind where case studies and data collections are essential in order to fulfil the design goals and objectives; I have studied the following:

1. AREWA BOTTLERS, KADUNA-(Produces Pepsi-Cola and Mirinda)

This bottling industry, is located at an industrial area of Kaduna, i.e. Kaduna South. It is a division of JOHN HOLT LIMITED. It started production on the 1st of July, 1980 and has a production capacity of 25,000 bottles per hour. Production is done for 8 hours with single shift per day. Production interms of crates is $\frac{25,000}{24}$ x 8hrs. Note that there are 24 bottles in each crates or cases. Thus the factory produces about 8,500 crates per day. But production depends largely on some influential factors like market demand, efficiency of the machine, and of course the production workers. There is less human labour, the process is is almost completely mechanised.

Design wise, the factory has been properly designed. The zoning and functional relationship

between the various units has been achieved. The only snag with the planning is circulation. Apart from the main entrance which has double in-lets (in and out) there are about two other entrances. One of them, is for the purpose of delivery of raw materials while the others are for emergencies. A factory of this kind ought to have some kind of security. By having so many gates or entrances, the aim has been defeated. Other positive values in this factory, includes high degree of cleanliness in the production process and the factory surroundings. Unlike other bottling industries, this factory; the production hall in particular is completely enclosed, with good structural, and lighting solutions. Note that most of soft drinks factories are semi-opened.

Raw Materials

The principal raw materials are sugar, concentrates, carbondioxide and water (treated water). Other starting materials include empty bottles with crates and crowns.

Sources of Principal Raw Materials

Concentrates are imported from the United States of America. Sugar is obtained from Tate and Lyle

Nigeria Limited, Bacita. Carbon-dioxide is bought from Nigeria Bottling Company, Apapa-Lagos. These are bought in cylinders but there is a proposal of carbondioxide production plant to supplement the supply from Lagos. Water supply comes from the Municipal Water Supply.. There is one big storage tank and two opened concrete water storage tanks. This water is treated to the factory's specifications for the use in the production of soft drinks. Some of the personnels are expertrates but majority are Nigerians by Nationality.

Population Chart

The break down of workers population in the various departments and units has not been disclosed to me, for confidential reasons, but a reliable source puts the total number of workers in factory at 120 as at January, 1983.

Workers' Facilities

A separate block of building has been provided just adjacent to the administrative block to cater for workers needs such as canteen, common-room, changing room and others. There is also a free medical services: First Aid Room is provided, but serious cases are refered to a specialist hospital.

2. BRAHMA SOFT DRINKS BOTTLER

The Drinco Industries Limited, Kaduna is the Brahma Soft Drinks bottler. Relatively young, has a production capacity of 250,000 bottles per day. Just like the other bottling industry, their production also largely depends on some factors, like market demand and others which has been described above.

There products includes Brahma Guarrana, Brahma Lemon and Brahma Orange. The factory is properly planned, only that, administrative block is too far from the production hall. General circulation and functional relationship of the various activities within the factory has been achieved. The production hall is opened at one end. High degree of cleanliness is fairly achieved especially in the production hall. Apart from the above mentioned positive values, there is good structural solutions, good lighting and ventilation. Not much mechanical ventilation is employed.

Raw Materials

Like the other factory, the principal raw materials are sugar, concentrates, carbon-dioxide, and treated water.

Sources of Raw Materials

The concentrates are obtained from Brazil. Sugar, from Tate and Lyle Nigeria Limited, Bachita, some are bought from overseas. Carbon-dioxide is bought from the Nigerian Bottling Company Limited, Apapa-Lagos. Usually, they come in the cylinders.

Water supply is from bore holes. The factory therefore, does not depend on the Municipal Water Supply.

Population Chart

Like the other factory, the breakdown of workers' population has not been disclosed to me, but a reliable source told me that the breakdown in some department and units are as follows:

Account Department	6
Administration Unit	30
Treasury Unit	2
Personnel	4
Commercial Department	70
T o t a l =	114

Workers' Facilities

One of the negative value with this factory is lack of workers' facilities, staff canteen in particular. Only small first aid box is provided for the

production workers. But no clinic, except that serious cases are usually transfered to a specialist hospital at the expence of the factory management.

General

The factory is located in a light industrial area of Kaduna-Nasarawa industrial area. The site in which the factory is located is not easily accessible from the highway.

3. NIGERIAN BOTTLING COMPANY, KADUNA

This is a relatively old bottling company, which has production capacity as follows:

1st Line: Rated at 15,000 Crates daily.

2nd Line: Rated at 10,950 x 2 — 21,900 crates daily.

Total number of crates produced daily are 36,900 crates. The factory works on two shifts, each shift working for 10 hours. First production line is completely manual. The second production line is semi-automatic. This factory, has so many short comings. The General circulation of all activities in the factory is poor. The functional relationship of the various units and departments

has not been achieved, hence, poor zoning. Production Workers are not comfortable due to chaotic arrangement in the production hall. Production hall is very dirty.

Principal Raw Materials

These are Sugar, concentrates, carbon-dioxide and treated water.

Sources of Raw Materials

Concentrates are imported from the United States of America. Sugar is obtained from Tate and Lyle Nigeria Limited in Bachita. Carbon-dioxide is obtained from Nigerian Bottling Company, Apapa-Lagos. These are bought in cylinders but, there is however, a Carbon-dioxide production plant to supplement the supply from Lagos.

Water supply comes from the Municipal Water Supply. In addition there is one big water storage tank.

Water treatment tank is divided into two sections of about 25,000 gallons each. A pump, pumps water from the tank to the filters, and this passes through sand of various sizes coarse and fine aggregates, from which it goes to the carbon filter containing activated carbon. Measure quantities of

hydrated lime, chloride of lime and ferrons sulphate are used to remove chlorine in the water. Other foreign materials are filtered out through sand filters. The treated water is stored in storage tanks which are of cylindrical shape of 3m. length and 1m. diameter.

Syrup tanks are of 3m. diameter and 3m. height. Carbon-dioxide man hole directs carbon-dioxide to the points where it is used in the production hall. Steam passes through piping to the bottle washer machine.

All personnel are Nigerians by Nationality.

Population Chart

Production Unit	153
Storage Section	15
Administration	25
Maintenance Unit	35
Services Section	10
Package Section	10
Sales Unit, Co Production Plant, NH Production Plant, Water Treatment Plant	215
T o t a l =	463

Workers' Facilities

There is an average restaurant adjacent to the production zone. The factory management provides free medical services to its employees, there is no clinic, except the first aid room. Serious cases are refered to specialist hospital at the expence of the factory's management.

have only part 1 concentrates while products like Sprite, Fanta Orange, Ginger Ale, Fanta Tonic and Krest Bitter Lemon have both part 1 and part 2 concentrates.

Part 2 concentrates come in glass containers and part 1 of Coca-Cola and Soda water, they are kept under cold storage condition, with a temperature of about $2^{o}C$, being the lowest practicable temperature. Different kinds of concentrates give different kind of soft drinks. (That is, they give their corresponding soft drinks).

The concentrates part 1 and part 2 are mixed in the ratio 1:1 before they are employed in the production of soft drinks.

CHEMICAL COMPOSITION OF SOME COMMON SOFT DRINKS PRODUCT

	PRODUCT	VOLUME OF H_2O	VOLUME OF SUGAR	CONCENTRATES		UNIT OF RESULTING PRODUCT	QUANTITY OF PRODUCT PER UNIT	GAS CONTENT PER BOTTLE
				PART 1	PART 2			
1.	COCA-COLA	40 Gallons	203.2kg	1 Unit	1 Unit	One Unit	270 Crates	3.7
2.	SPRITE	40 Gallons	204.0kg	a + b 1 Unit	1 Unit	One Unit	282 Crates	3.7
3.	FANTA ORANGE	"	268.5kg	"	—	" "	" "	1.7
4.	GINGER ALE	"	179.0kg	"	1 Unit	" "	" "	3.7
5.	SODA WATER	"	160.0kg	"	—	" "	" "	4.0
6.	FANTA TONIC	"	169.0kg	"	—	" "	" "	3.7
7.	KREST BITTER LEMON	"	242.5kg	"	—	" "	278 Crates	3.5

5.4 TREATED WATER

In any soft drinks processing industry, clear water free from bacteria and or unwanted particles is very essential. The water employed in the production of soft drinks must be purified and well taken care of, micro-organisms.

For filteration, water from Municipal Water Supply joins the aerator, at this point the particles are decomposed. It is then passed through pressure sand filters where particles are removed. Water leaves the filters and joins the Ozonator where Ozone is added as oxidising agent. By the time water leaves the Ozonator it is good for the production of soft drinks.

5.5 STEAM WATER

Steam water may be considered as one of the starting materials for the production of soft drinks. It is employed in washing of bottles, production of steam usually takes place at the boiler house. Water from Bore holes or municipal water supply is suitable. The water is passed through ionic resins before it joins the boiler. Calcium or iron is added as the ionic resin to remove substances that could hamper boiling.

5.6 CARBON DIOXIDE

Carbon dioxide is produced in part of the auxiliary facilities. Air is compressed directly from the atmosphere. This acts as counter pressure to the carbon dioxide used in the production. Carbon dioxide is produced industrially on a large scale basis. For soft drinks it is usually in the form of "dry ice" which is solid form of Co_2 (carbon-dioxide). It contains pure carbon dioxide. Carbon dioxide manifold directs the gas to join the production process at the bottling hall. The diagram attached indicates a schematic diagram of carbon dioxide production plant.

5.7 FINAL SYRUP

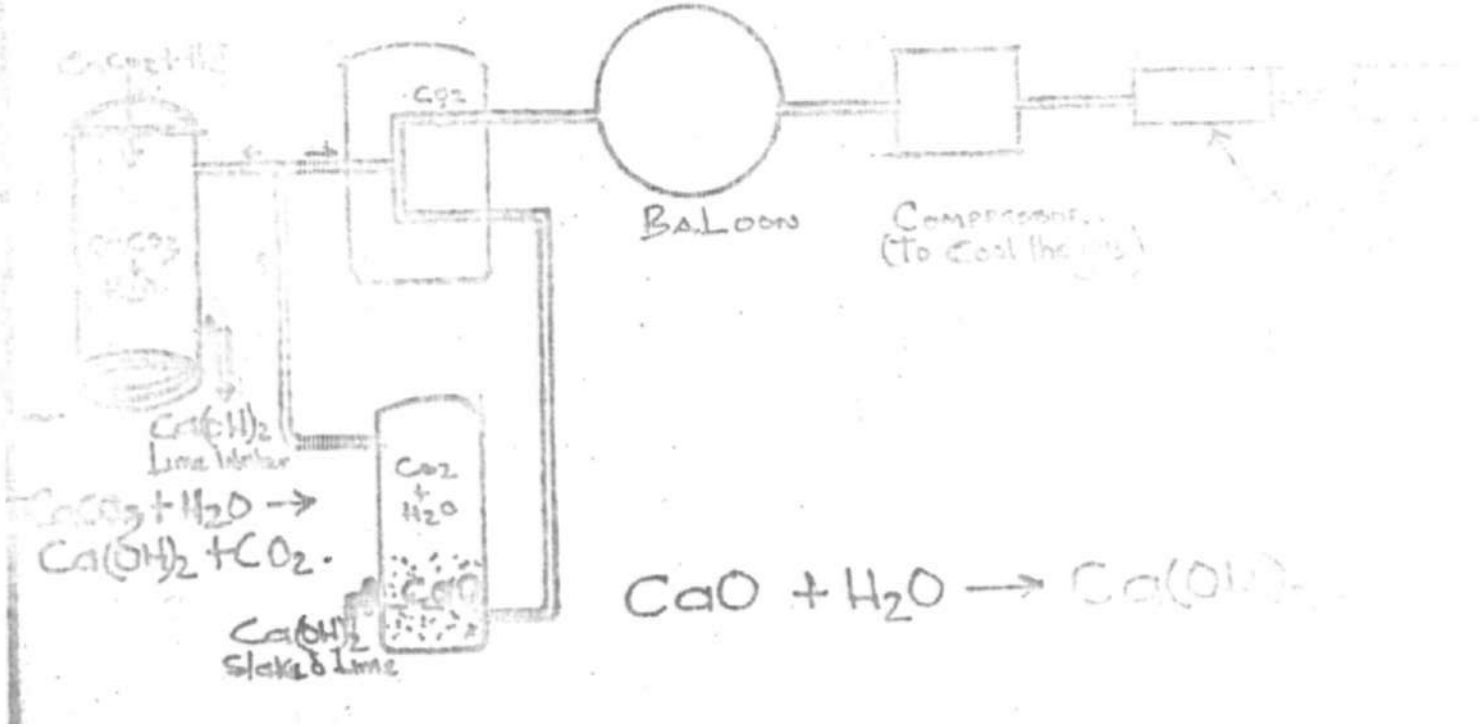
Part 1 and 2 concentrates are added to the simple syrup or light syrup to form final syrup. This is the beverage in high concentration. It leaves to join the filling point by means of pressure action.

5.8 EMPTY BOTTLES IN CRATES

The dirty empty bottles in crates are conveyed to an unpacker machine by means of a conveyor belt.

CO_2 PRODUCTION PLANT.

For Carbonated Beverages, it is usually in the form of "dry Ice" which is solid form of CO_2. It contains Pure Compressed CO_2.



$$CaO + H_2O \rightarrow Ca(OH)_2$$

The unpacker machine packs the empty bottles from the crates and place them where they are conveyed to an empty bottle washing machine. While the bottles are carried to washing machine, the empty crates follows a different conveyor to an empty crates washing machine. The empty dirty bottles are properly washed by undergoing the following process:-

Custic Soda + Hot water —— Hot water only —— Cold water —— and finally Hot air to sterilised the bottles.

The capacity of the empty bottles washing machine is about 1,100 bottles per minute. These bottles are free from dirt or micro-organisms. They are checked at the inspection lights. The bottles that are not properly washed and broken bottles are manually packed. Thus, the bottles which leave the inspection light successifully, are ready for filling with syrup. The bottles join the bottling area via conveyor belts.

Final syrup passes through the MOJONNIER. The mojonnier is relatively big vessel in which the syrup, treated water and carbon dioxide are mixed. From this vessel; proportionated, mixed and carbonated beverage is obtained.

The type and colour depends on the concentrates used. The resulting beberage goes to the filling machine. Crowning of bottles takes place immediately. The filled bottles are made to pass through coding machine where the filled bottles are coded. After coding, it is made to pass through the inspection light, where the sighter would sit down and watch carefully and remove bottles that are either half-filled or broken. The bottles that leaves this inspection light passes through the meter which records the number of successful products. In this way, the total number of bottles produced per day could be determined. Final products are conveyed to the packing machine. This machine packs 24 bottlles into a crate at a time. Filled crates are arranged in pallets. This process of arranging the crates in pallets is known as Palletizing. Forklifts are called into pack and arrange those pallets in a storage area or Ware house, ready for delivery to customers.

5.9 BROKEN BOTTLES

Broken bottles or bottles that are in bad condition, could be stored and sold to Glass Making Industry or Bottle Making Industry.

5.10 AUTOMATIC LOADING AND UNLOADING MACHINE

The introduction of this modern and very recent equipments has in no small measure contributed immensely to the production rate in the soft drinks factories where these equipments are available.

The automatic unloading machine, unloads the dirty empty bottles from the crates in terms of four crates at a time, with a capacity of about 24 crates being unloaded per minute. The dirty bottles then pass through a conveyor belt to the bottle washer machine while the dirty plastic crates pass through another conveyor belt to the crate washing machine for washing. Clean crates joins the production line again. Via another conveyor belt to meet the filled bottles at the automatic loading machine which by a reverse of the unloading process, loads the clean crates with filled bottles.

CHAPTER - SIX

6.1 GENERAL REQUIREMENTS FOR THE BOTTLING INDUSTRY

Food Plant Sanitation

- Personal hygiene and public health of all personnel.
- Avoidance of contamination of the food or beverages by foreign matter.
- General cleanliness in and around the plant.
- Supervision should include the following:

  Maintenance of sanitary facilities within the plant.

  Care for sanitary and food plant wastes.

  Good care of plant of water supply.

  Supervision of dressing habits of the factory workers and production workers inparticular and general health of all personnel.

  Proper sanitation of mobile wagons and concessioned vending machines for the products.

Sanitation of eating and or housing establishments within the factory complex.

Proper care of heating, lighting and ventilation where public health or sanitation is involved.

6.2 WELFARE AND SANITARY FACILITIES

To maintain a satisfactory level or personnel hygiene the following should be provided:-

Provision for washing, changing and toilet facilities for both sexes - seperately.

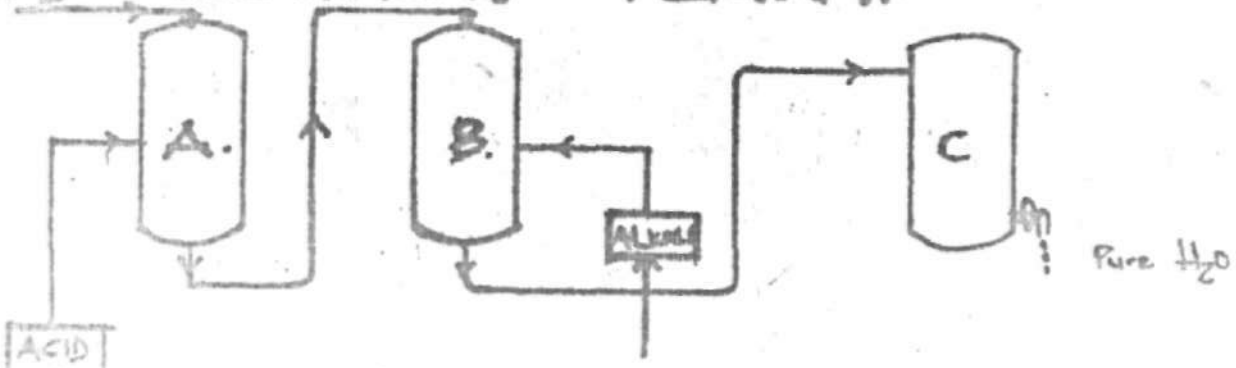
At least women common room. - Provision.of adequate safe drinking water. First aid facilities, cafeteria and coffee room.

6.3 WATER AND SEWAGE

The primary requirement in beverages and other food processing industries is availability of adequate water supplies of suitable quality. This helps in the choice of site and plants establishments.

Proper disposal of large volumes of liquid wastes accumulated during the production process is not unconnected with the sources of water considera-

H_2O TREATMENT PLANT.



Regenerating Solution.

Regenerating Solution.

A = Cation Exchanger.

B = Anion Exchanger.

C = Degasifier.

REACTIONS IN THE CATION EXCHANGER.

[illegible] produced by the Exchange of Hydrogen between [illegible] Exchanger (CE)

[illegible] $+ H_2\text{-}Z \longrightarrow 2CO_2 + 2H_2O + Ca\text{-}Z$

[illegible] $+ H_2\text{-}Z \longrightarrow$ [illegible] $+ Ca\text{-}Z$.

[illegible] $+ H_2\text{-}Z \longrightarrow$ [illegible] $+ Na\text{-}Z$

Water leaving tank A contains some Acids.

Regenerating Sol. $Ca\text{-}Z + 2NaCl \longrightarrow$ [illegible]

REACTIONS IN THE ANION EXCHANGER.

B = Acid Adsorption tank ie Acid is removed in this tank.

e.g $HCl + Z\text{-}OH \longrightarrow Z\text{-}Cl + H_2O$.

Water Leaving B is Pure except for Co_2.

C = Degasifying Tower.

CO_2 is removed here. The H_2O leaving tower C is equivalent to distilled [illegible]

hamper the processing of water and undesirable for boiler feed.

A typical water treatment plant is shown in the diagram below.

Water employed in vapour condensation, fire protection, washing (general), general plant clean up, dilution of wastes, conveying raw materials and related activities, soluble salts present in water could generate steam corrosive to the bodies where applied.

6.5 SEWAGE

Some plants are faced with problems in disposing of their industrial process water. Although waste disposal systems are based on establishment of chemicals and physical principles, these systems vary widely in design. These differences are due to differences in the waste composition and in geographical location or community requirements.

For a plant such as the soft drinks factory that uses water as one of its principal raw materials for the industrial processes, the quantity of water required for personnel facilities is usually a small percentage of the total demand. A desirable minimum

capacity of water for personnel facilities is ordinarily considered to be thirty to fourty gallons per employee per eight hour shift.

Frequently plants that employ a large number of female workers find their water consumption for personnel facilities may run as high as sixty to eighty gallons per person per shift.

6.6 WATER FOR FIRE FIGHTING

The most effective method of fighting fires in a soft drinks plant is the automatic sprinklers which goes into operation when the temperatures reaches a given level. Water damage is minimized because only those sprinklers that are needed open up. If possible the source of water for fire protection purposes should be independent of outside source. An elevated gravity tank is usually required to feed a sprinkler system.

Location of fire facilities and fire equipments is an important safety consideration in plant layout.

6.7 STEAM

A typical factory today requires steam to:

(a) Supply hot water

(b) Heat its building

(c) Provide heat manufacturing operations.

The steam power plant can be a major capital investment when erecting a plant at a new location.

Steam is employed as a medium of heat, transformer in beverage plants just like in any other food plant. Oils, diphenyl, and silicans are employed in heat transfer in specialised operations.

Electric power, gas and oil is occassionally used to supply direct heat at points of application. In sterilising, concentrating, drying and aerating, steam is the best media of heat transformer. Steam is usually generated at a point and piped to the various points required.

Boilers consist of furnaces, water reservoirs, tabular heat exchangers and drums for collecting, seperating and steam delivery. Supplimentary equipments include, feeder water pumps, devices for regulating water levels and valves for relieving excessive pressures and to blow out sludged concentrated from the production line. Steam lines in boilers, deliver adequate steam of suitable quality and pressure to each point of application in the plant.

The amount of steam called for in a given plant may influence the plant to generate its own electrical energy.

When steam, air special gases, and water are distributed throughout a plant, the piping system can become quite complicated.

Pitsburgh plate glass company recommends the following colour coding for pipe-line identification.

PIPE-LINE IDENTIFICATION

C L A S S I F I C A T I O N	C O L O U R
Fire protection materials and equipments (Sprinkler system, etc.	Red
Dangerous materials (Acids, Gases, Steam 212°F)	Yellow or Orange
Safe materials (Drinking water, compressed air, steam below 212°F)	Black, Grey or Green
Protective materials (Gases or Liquids are used as antidotes to dangerous materials)	Light Blue
Extra valuable materials (usually safe, but of high value)	Purple

The various pipe-lines can be completely painted in the specified colour.

6.8 COMPRESSED AIR AND GASES

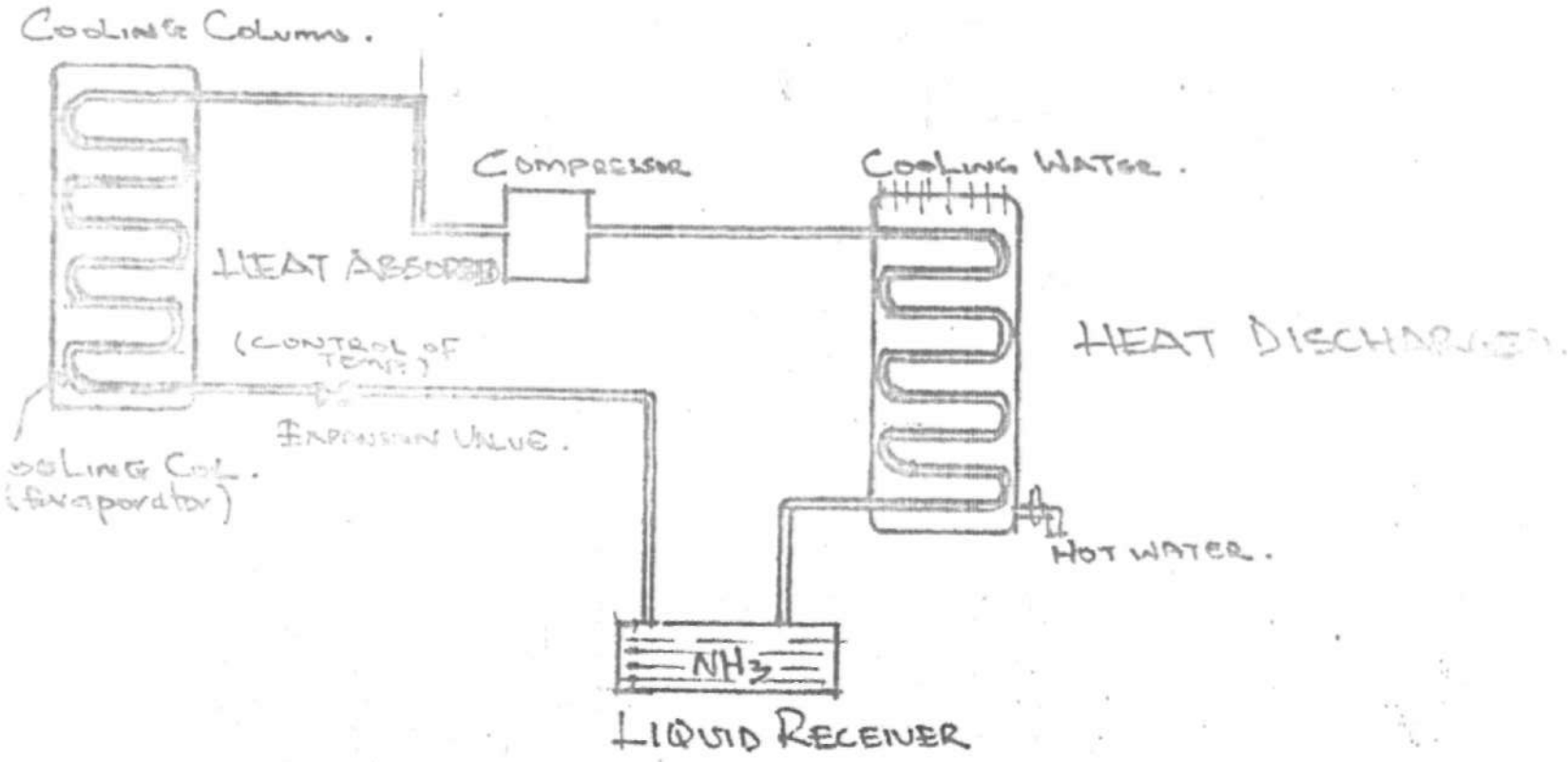
Compressed air is very useful in industrial plants. Not only is it often used for cleaning purposes, but often it is utilised as a preserving medium for soft drink products. For example carbon-dioxide (CO_2). The demand for these gases is not centralised in one area, as they come at various stages of the production process, they are supplied to the points of application through series of piping system. Thus, for instance, the amount of carbon-dioxide in some soft drinks product are as follows:

	PRODUCT	CO_2 CONTENT/BOTTLE
1.	COCA-COLA	3.7
2.	SPRITE	3.7
3.	FANTA ORANGE	1.7
4.	GINGER ALE	3.7
5.	SODA WATER	4.0
6.	FANTA TONIC	3.7
7.	KREST BITTER LEMON	3.5

Carbon dioxide used in the factory is prepared on site from the carbon dioxide production unit. See the attashed diagram of carbondioxide production plant.

Ammonia is used in the carbon cooler tank as a medium for refrigerations shown in the diagram.

DIAGRAMMATIC REPRESENTATION OF COOLING SYS IN THE CARBOOLER TANKS.



6.9 QUALITY CONTROL

The establishment, maintenance and control of quality deals with the determination of quality standards and the measurement and control necessary to see that the established standards are maintained and practiced. These standards may be specified d dimensions, chemical compositon of raw materials, hardness, etc.

It involves qestions of how quality in the products is really measured by consumers. It is measured by appearance, taste and flavour in the case of soft drinks products and possibly storage durability, that is ability to maintain the original taste for quite a longtime.

How sensitive is the production cost and needed plant investment to these measures of the quality of a particular product? Therefore, in relation to the market potentials, what is the competitive situation at various quality levels within the particular industry? These and other considerations may determine which sector of the market an organisation shoots for.

The detailed specifications of quality to be produced are set by the product designer when he determines materials to be used and their specifi-

cations, dimentions and product capability. Here of course there is an interaction between what can be specified, what can be produced, and the cost of production. Thus, there is a complex process of design for quality, production design of the product and the design of the production system itself, each one affecting the other to some degree.

6.10 QUALITY CONTROL IN MANUFACTURE

Quality control in manufacture is infact, the thing which is brought to mind to most people by the term "quality control". In actuality, we have three important sub-phases which describe quality control in manufacture. These three phases are centred around:

i. The inspection and control of the quality of incoming raw materials.

ii. The product inspection and control of production processes.

iii. The inspection and testing for product performance.

It is in these sub-phases that the well known techniques for inspection and statistical quality control find their greatest application.

The objectives of quality control in manufacture are to implement the quality standards by measuring characteristic of the raw materials, parts, and products, comparing these measurements with established standards so that we may

i. accept or reject, and

ii. correct performance through information feed back. Thus, the techniques of acceptance inspection and sampling provide control by filtering out items which do not meet standards.

The information feed back from various inspection and production operations provides data for the possible revision of the quality standards and of product designs as in the diagram attached.

We must draw a distinction between inspection and quality control. Inspection involves setting up a way of measuring the quality characteristics and comparing them to quality standards. Obviously the good parts are seperated from the bad parts in this way, but no corrective action is implied. Control raises questions of when and how often to inspect, how many units to inspect, and when defective units occur, control determines the cause and corrects it so that more defective units are not produced, probability concepts play a dominant

role in the control phases by setting up sampling plans which can control out-going quality, and through control chart procedures which continually track critical machines or processes.

However, the control of quality in soft drinks factories calls for extra vigilance as the products are going to be consumed by human beings, and any serious defect may result in death, since lives are involved, extra care must be taken in quality control of soft drinks products, before they are disparched to consumers.

5.11 POWER ELECTRICITY

Electrical energy is highly used in modern food and beverage factories. This form of energy is employed in:

i. Conveyor Belt

Flight and screew conveyors, bucket elevators, pumps and fork-lift trucks.

ii. Mixing

Dry and wet mixing of sugar, concentrates and doughs. Seperating peeling, curing, pitting, slicing, juicing, etc.

iii. Compressing

Air and refrigeration compressors plus vacuum pumps.

iv. Air Handling

Blowers and fans for dehydrators, dries, ventilators, and air conditioners.

v. Packaging

Automatic loading and unloading machines, fork-lifts, etc.

6.12 MAINTENANCE FACILITIES

All industries must perform some types of maintenance. Maintenance activities fall into a number of categories. With respect to plant services, the maintenance services or department is responsible for the repairs in the heating and plumbing system, the lighting and power system, and communication systems and to provide painting services.

Maintenance department may be required to over-haul or install machinery and equipment. They are also responsible for the repair of transportation equipment and maintenance of fire and office equipments. Often the clean-up function falls to the maintenance department.

A good maintenance shop should provide easy accessibility to the production hall, so as to provide quick service on minor repair jobs. Quick

service can be critical in the producrt type of lay-out, where the breakdown of one piece of equipment can terminate the output of a complete production line.

6.13 COLD STORE

Cold storage maintains varying degrees of temperatures. Cold air continous circulation is the mechanism. Ammonia or Brine are the ideal gases. These systems are closed, that is, the re-circulation of the same cold gas. Mould is likely to grow in cold stores and it is an enemy of the cold store, as this easily attacks the items stored.

6.14 DESIGN OF COLD STORE

The main factors to be considered when designing cold storage are:

1. Number of storage rooms.
2. Number floors in the building.
3. Position of loading bay and the number of lifts.

These could be constructed of concrete block or bricks with the insulation of the walls, floors and ceilings. Glass wool, cork and other insulation materials could be employed. Curtain walls

are ideal since there is the advantage of free movements of wall in dependently.

There could be ready-made cold storage boxes of smaller capacities of Metal Products like the searl Bush (Allumaco Cold Storage Boxes). Insulation is by enclosing small air in the bodies which are impervious to moisture penetration. The walls are damp proofed before the construction of the cold stores.

The insulation materials are required to be ordourless, powerless, to paint and perishable goods, Moisture free, fermentation free in course of damp situation, vermin proof light weight, fire proof and easily installed. Insulation materials include fibre board, cardboard, cellur bricks, glass wool, rubber in sheets and cellular form and varieties of wood-like balsa wood and wood fibre. Cold stores is an essential aspect in food processing industry. Without the cold storage facilities, raw materials are likely to perish in no time.

6.15 COLD STORE EQUIPMENT

— Refrigerating machinery.

— Apparatus for lifting and elevating.

— Handling equipments.

Bello University

— Scales and metres plus other recording instruments like thermometres and hygrometers.

— Lighting is essential in cold stores to enhance cleanliness but increases heat that must be taken care of, light is therefore, placed only at places of high concentration.

6.16 THE LOADING AND UNLOADING BAYS

The unloading bay should be about 8% of the total storage area. This should provide adequate space for off-loading. The loading bay should be clear of columns and lift shafts and should face the plat-form to avoid unnecessary manouvres. 100 tons daily movement of goods averages 30 - 36 trucks (10 - 12 rail wagons). 50 tons intake by rail represents the unloading of 8 - 10 rail vans. Thus, 30 tons by road (7 - 9 lorries) on the average.

6.17 POSSIBILITY IN ADOPTING MECHANICAL VENTILATION IN THE PRODUCTION HALL

Mechanical ventilation could be essential in the production hall, due to the following factors:

i. Removal of odours and fumes.

ii. Air and gases exhaled during production processes, for example CO_2, NH_3 gases.

iii. Moisture liberation within the production hall, for example steam.

iv. Smells of smoke, body ordours and bacteria.

Mechanical ventilation, if adopted could take care of the above mentioned factors. Apart from taking care of those factors the mechanical ventilation would supply fresh air which is necessary to supply human lives in good and hygienical and sanitary conditions.

6.18 THE EMPLOYEE

Whenever plant layout are under consideration, thought must be given to the comfort and convenience of the employee. An employee dissatisfied with a layout arrangement that affects him, can and does object it through the channels provided by his labour union. Therefore it is necessary for the designer to predict what demands the employee will place on the arrangement of facilities.

Today's industrial standards demand food service, medical services, lavatories, and locker rooms for employees. Food service is provided by the cafeteria.

Proper working conditions are considered important by management because they increase productive effectiveness. Good layout considers lighting, air-conditioning, noise control, use of colours, and operator space requirements as well as safety requirements to aid in creating desirable working conditions. Other employee factors, such as organisational structure or wage incentives can also influence plant layout solutions.

CHAPTER - SEVEN

7.1 CAPACITY DECISION

In contemplating a new plant design or the re-design or expansion of an existing system; a high level decision on the design cpacity is required. It is not enough to simply look at annual sale of various products, because the sales pattern may reveal seasonal fluctuations.

At this stage, one should find out whether to design for the peak or for some average levels. However, if one choose to follow the sales curve, one will minimise risks, but will have a fluctuating labour force, and therefore the plant will have less capacity during the peak production. If an intermediate level is adopted, the tendency is to stabilised employment levels, and to utilise plant facilities better, but it is also necessary to design the factory in order to meet the sales peak. A project that will minimise the combined cost of the factory, the investment costs and labour turnover costs is very necessary.

A straight line production layout can be considered as a simplified example, A typical example is a bottling plant with the production line made up of the following operations:

i. Bottle Washer

ii. Syrup Filler Machine

iii. Crowner Machine

Theoritically, a straight line production arrangement would involve the out put of operation one, feeding directly into operation two, and so on, down the line. The out - put of the line would be the required actual out-put, and this would be constant for all operations. Practically speaking, this situation is seldom achieved because of machine break downs, materials shortages, workers leaving the line, etc.

In practice, temporary adjustments are being made rather frequently. However, there are some limitations such as:

i. Automatic trips are built into the conveyor line to stop the conveyor when the maximum number of bottles fills up the conveyor length.

ii. The out-put from operation two (syrup filler machine) can not exceed the out-put from operation one (Bottle washer machine), out-put from three (crowner machine) cannor exceed the out-put from operation one, out-put from three cannot exceed the out-put from two, and so on.

The second limitation requires us to consider a model utilising conditional probability. Conditional probability is defined as the probability that an event Y will occur given that event X has occured. This can be written in Mathematical Symbols for easy illustrations as follows:

$$P(Y/X) = \frac{P(X,Y)}{P(X)}$$

A simplified conditional probaility example would be the out-put of operation two is conditional upon the out-put of operation one, as follows:

$Pa_2, a_1(a_2a_1)$ = Conditional probability of producing a_2 units in operation two having already produced a_1 units in operation one.

$Pa_1, a_2(a_1a_2)$ = Probability of producing a_1 units in operation one and a_2 in operation two.

and $Pa_1, (a_1)$ = Marginal probability that operation one will produce a_1 units.

Multiplying both sides of equation (A) by $Pa_1(a_1)$ then, $Pa_1, a_2(a_1a_2) = Pa_1(a_1)\ Pa_2\ a_1(a_2a_1)$ — (B) from the limitations, operation two is dependent upon operation one only that it cannot produce more than cperation one.

If the bottling plant has a schedule of ninety-six bottles per minute it is equivalent to think of this schedule at the rate of sixteen bottles per 10 seconds interval. All of the three operations have the same variability. The out-put of each operation closely approximates a poison distribution with a mean of 16 and a standard deriation of 4. The implication is that, any of the machines may process more or less than sixteen bottles per time interval, but on the average, the machines will complete sixteen bottles per interval.

To calculate the expected percent of the time for processing bottles per time interval, that is, per 10 second interval, would be as follows:

$$P(c) = \frac{U^c - U}{C_1} = \frac{16^8 - 16}{81} = 1.2$$

from the poison distribution where C = 8 and U is the mean of poison distribution, that is, the average out-put of the line over the long run which is 16 and C is the number of bottles processed.

Let the work in process storage space between operation two (syrup filler machine) and three (crowner machine) be considered. The out-put of operation two is a poison chance variable with a mean of 1.28 bottles per second. This quantity is obtained from the sum of the products of column 1 times column 2 all divided by the total of column 3.

With the queing approach, the out-put of operation two is the same as the arrival rate at operation three is 1.28 bottles per second.

EXPECTED TIME FOR PROCESSING BOTTLES

Column 1 Number of Bottles Processed	Column 2 Operation One	Column 3 Operation Two	Column 4 Operation Three
5	0	0	0.867
6	0	0.7	3.220
7	0	2.0	5.690
8	1.2	4.35	8.960
9	2.1	6.78	11.900
10	3.4	9.36	13.900
11	5.0	11.53	14.900
12	6.6	12.61	12.840
13	8.2	12.62	10.470
14	9.3	11.40	7.610
15	9.9	9.50	4.950
16	9.9	7.30	2.900
17	9.3	5.12	1.500
18	8.3	3.32	0.575
19	7.0	1.97	0.173
20	5.6	0.99	0.000
21	4.3	0.37	0.000
22	3.1	0.11	0.000
23	2.1	0.00	0.000
24	1.5	0.00	0.000

7.2 FUTURE CAPACITY

Provision is made for some forecast level of above five to ten years ahead. This has been achieved by providing more space apart from the proposed three production lines. The space could be used for temporary storage of new empty bottles and crates and other related materials. Thus, planning is for a future capacity, but extra over-head is carried for the building space only, as only equipments for current needs would be purchased fro from time to time, and when an additional capacity is needed, machines for the fourth production line can be integrated into the system without need for relay-out, and without much disturbance on the existing production lines.

Some additional space is justified when one considers that space added later is more expensive per square metres, because existing walls must be removed, doors cut through to the new space, the escalating rate of imflation in the country one year after the other, and so on, More important than the cost of the additional space itself are re-layout costs, which would be required to integrate the new space into the production system, but becomes a 'thumb' stuck onto the existing lay-

out, an extra costs is paid daily in the form of higher material handling costs. These extra costs of adding future space must be balanced against the incremental costs of building more space now, and carrying it as added over-head until it is needed.

7.3 EQUIPMENT

Machine and Equipment without a doubt have greater influence on a layout solution than any other factor. It would be impossible to make an optimum layout without complete and factual information about the machinery and equipments involved.

Engineering economy is a technique that can provide great assistance in the selection of machinery and equipment. Some of the automatic equipments such as the bottle washer machines with the pre-rinse, and final rinse compartments built into one machine, and the automatic loading and unloading machines help in no small measure to achieve a reasonable increase in the rate of production per day as compared to the soft drinks factories where such modern machines are not available. This is infact one of the principal factors in achieving a production of about 24,000 crates per day.

In addition to information about the physical dimensions and clearance of the machines, tools and equipments which are important in the layout work. These can be summarised as follows:

(a) Operator location

(b) Services required

(c) Routine maintenance requirements

(d) Emergency maintenance requirements

(e) Location of controls

(f) Hand operated power tool requirements

(g) Tools required.

CHAPTER EIGHT

THE INDUSTRIAL COMPLEX

8.1 TYPES OF CLIENT

Although the project is a medium scale type, large sum of money has to be invested at the initial stage.

i. It involves the building of the industrial complex.

ii. The purchase of the machinery.

iii. The maintenance and management of the factory.

Due to the magnitude of the project, the proposal for the running of the project is to be done by the Kaduna State government, Zaria Local government, private individuals, and the Industrial Development Banks. The proposal for their shares is as follows:-

Kaduna State government	- 40%
Zaria Local government	- 25%
Private Individuals	- 20%
Industrial Development Banks	- 15%

Ultimately, Kaduna State government is expected to buy the shares of the Industrial development banks while private individuals buy that of

the Zaria Local government. After some time, the private individuals could be the owners of the factory after buying the state government's shares.

8.2 ANALYSIS OF DIFFERENT SECTIONS OF THE INDUSTRIAL COMPLEX

i. The Loading And Unloading Bay:

There are four zones within this area namely: The empty bottles zone, Final products or filled bottles zone, the fork-lifts zone and the trucks zone. The production Hall is open to the loading bay.

ii. The Main Production Hall:

This Hall houses all the machinery equipment that is necessary for the production of soft drinks. Apart from accomodating machinery equipments, it also houses storage facilities for the raw materials. Preparation of syrup and carbon dioxide takes place at the end of the production Hall. Other units that are attached to the production Hall includes: Ammonia Compression plant, offices, workers facilities and other auxillary facilities as shown on the detailed drawings. The production Hall being the focal point of

whole complex, as such it is positioned in such a way that it is self-advertising to the customers. It is easily accessible from the major road.

iii. Administrative Building:

This building or block, houses all the sections of the establishment connected with the day - to - day running of the factory. This block serves as a co-ordinator between the outside and the factory, as such its positioning calls for taking great care to make sure that it can easily be identified. This has been achieved in the proposed design as it is made to be the only storey building and is located at the for- front of the complex closer to the way of approaching the production Hall. This block accomodates offices for keeping records of accounts, production, all purchases and sales, advertisements, and other important documents necessary for the effecient functioning of the factory. The entrance to the block, that is, customers entrance, is well treated to portray reception and this

helps in identifying the block to an approaching customer.

iv. Parking Space:

Parking spaces are apportioned to customers and a separate one for the administrative workers. The seggregation of the two parking spaces was found to be appropriate as the customers are linked with the show - room or soft drinks restaurant.

v. Soft Drinks Restaurant/Show-Room:

The administration also houses the show-room or soft drinks restaurant. It is positioned facing the parking space so that customers arriving on vehicles are made to pass it on their way to the reception. Those customers or visitors who may use other means of transport come into contact with the show-room while at the reception. This is of great importance for advertisement purposes.

vi. The Common Facilities:

The modern industrialist now accepts the fact that to be able to reach the maximum output and maintain it, he has to incorporate in his project a sound

welfare programme to at least maintain if not promote the health of his staff. It is expected that the services of a medical Doctor will be made available to the needy patients once in a week. It is also to be arranged that the Medical Doctor will be in the factory clinic every Wednesday between 9.00 - 12.00 noon. Also incorporated in the medical programme is the services of the two nurses and one dispenser throughout the working hours every day.

vii. Canteen:

In business, time, means money, and therefore incentives given to workers promote productivity. Considering the distance of the site from the town, there is a high need for designing a feeding area for the workers and it is expected that standard food will be sold to the workers at a subsidised price. This will ensure that the workers could have a quick and cheap meal without actually leaving the factory area.

viii. Changing and Common Room:

A common room attached to the canteen is provided where workers on shift who arrived before their time is due could relax and wait for their turn. They can also use it during break. Workers who bring their food for break-fast or any other meal can take it there, in which case, they don't have to go to the canteen.

Lockers, showers, toilets and washing facilities are made available for the use of factory workers. The changing room is so placed such that is very close to the

viii. Changing and Common Room:

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Lockers, showers, toilets and washing facilities are made available for the use of factory workers. The changing room is so placed such that is very close to the production hall, so that production workers can ease themselves without wasting much time.

ix. Workers' Entrance

A seperate workers' entrance and clocking is provided so that workers do not have to wait on the road, that is by the gate-house and cloak there. This is considered unfit for modern factory design. The entrance is so provided such that a direct line of movement for the factory workers is achieved.

x. Gate House:

The gate-house in the factory, is so positioned so as to allow a proper control of in-coming and out-going vehicles, staff and also the public.

CHAPTER - NINE

DESIGN CONSIDERATIONS

9.1 Sitting and Layout

The factory is sited in the Proposed Light Industrial Area of Zaria, that is near Dogarawa Village along new Kano Road. The whole complex is sited to the East-south of the New-Kano Road. Thus, the site is bounded by two secondary roads. One, is an existing one that is adjacent to the New-Kano Road, while the other is parallel to Kano Road. The emergency gate is located to the existing secondary road, while the Main-entrance or gate is to the other road. The purpose of locating the main gate in this way, is to allow smooth flow of traffics and to make the factory easily accessible to production workers and other workers in general and customers in particular.

Vehicular circulation is such that, the heavy traffics are restricted towards the production hall. These vehicles includes trucks that brought in raw materials and fork-lifts which packs the finished products in pallets for loading. Light traffics such as cars, bicycles or motor-cycles are controlled at the other side of the main product-

ion area. Parking space for customers is outside the main gate - this is to avoid embrasement as any customer who enters with his car, has to be checked to make sure that he/she did not come out wich any of the factory's property.

9.2 FUTURE EXPANSION

The factory has enough land for expansion in future. Expansion would be in two phases. First, by increasing the number of shifts from one to two. Finally, the factory could be made to expand by $\frac{2}{3}$ of its initial size.

9.3 DESIGN CONCEPT

The factory is properly zoned. Workers, facilities, the canteen and common room in particular are in good relationship with other, departments. The internal condition of the main production hall has been designed so that a high degree of cleanliness could be achieved. An internal wall is provided so that contamination from out-side is avoided. And the whole process is carried out in good hygenic condition. This is part of my contribution towards the Architecture of Soft Drinks Factory.

The sales department is in good relation with the storage of finished products and the loading bay; and therefore, customers would find it easy for their business. The factory is well planned so that proper delivery and evacuation is achieved.

9.4 FUNCTIONAL ASPECT

The production process is the arrangement of different functional units of the factory and it is such that co-relates with the sequence of the production process. That is, from the intake of raw materials to the despatch of finished products. Preparation of simple syrup and final syrup for production of soft drinks takes place in one end of the production hall, while the main production takes place in the production hall. This is followed by the finishing, like crowning, packing into crates or cases and subsequent arrangements in readiness for transportation by trucks.

The position of these stages of production process is well explained in the sketched plan. A schematic production flow diagram is prepared for any-one to know the sequence of production, that is, what stage comes before the other or what stage of production comes after the other. The production flow is a U-flow type.

9.5 STRUCTURAL CONCEPT

The basic structural grids used are 5.0 x 6.0m. in the administrative block. This is so, because less space is required. In the production hall, where large space is required, the structural grids are 4.5 x 18m. In the administrative block and other departments, reinforced concrete columns are used, while a multispan lattice steel roofs is employed in the production hall.

9.6 VENTILATION

Cross ventilation is ensured by providing proper and adequate openings in the opposite directions of each unit or departments.

For satisfactory ventilation, spaces for large numbers of people, such as, production hall must have cubic content of $3.00m^3$ per person. At an air intake rate of $30m^3/h$/person in spaces where smoking is permitted. Number of air changes per hour is ten.

Since Draught proof installations with this rate of air change is not adequate, it is therefore, better to increase the cubic content of the space, thus the need for using steel truss-roof which would increase the clear distance of the

ceiling, hence increasing the cubic content of the space, thus the need for using multiple lattice steel truss which would increase the clear distance of the ceiling, hence, increasing the cubic content of the space to enhance proper ventilation

9.7 LIGHTING AND ILLUMINATION

Lighting of all kinds play an increasingly important part as a tool of the Architect. Today, is is no longer sufficient to consider only the external day time appearance of a building. Buildings are supposed to be made for people and it is their needs which should be satisfied.

The architect's task is to cater for those needs within a structure which will also conform to the long, established parameters of design. It is therefore, necessary to consider and use to fill advantage of all the individual elements of the total environment. Lighting, natural and artificial, is most important of all.

Work place should be illuminated so that no shadow is cast on working areas. Light mostly arranged to come from front and left. Where quality of light should be similar to day-light like in the soft drinks factory, Natural Sky Light should be

used. To achieve the greatest similarity with the day-light a particularly high degree of illumination is important.

The Sky-light permits down-ward direct light and reduces side lighting to a smaller degree with only minor collection of dust which could be cleaned from time to time.

Illuminated ceilings for offices consist of flourescent lamps fitted above, for example, crates louvred lighting. Strip light with flourescent tubes produce even, general lighting without pronounced shadows.

9.8 R O O F I N G

The functional aspect of having large floor areas unobstructed as far as possible with columns supporting roofs could be achieved by having a single span lattice steel roof.

Multispan Lattice Steel Roof

Manufacturing process, no matter how small it is requires large floor areas which is unobstructed as far as possible with columns supporting roofs. There is no theoretical limit to the span of a lattice steel truss roof, but with increase in span the height of the apex of the

roof increases and a truss spanning say, 60m. would have a depth of some 12.0 at apex with a $22\frac{1}{2}^{o}$ symmetrical pitch roof. The only snag with this is the gross volume of unused roof space and the great number and length of the members of the lattice steel trusses. If, however, the same area is covered with four separate trusses a considerable saving in length of truss members and volume of roof space is effected. It should be noted that the area of roof covering is the same for the single 60.0m. span roof as it is for the four separate trusses. One of the most commonly used methods of roofing large factories is with multispan symmetrical lattice truss roofs. The span may be up to 30.0m. Obviously if the floor below is to be as free as possible from internal columns, it will be wise to fix a steel valley beam between columns to give intermediate support to trusses. If fewer internal columns are required then a deeper valley beam is necessary. For example a valley beam spanning 18.0m. between columns will be 800mm. deep and one spanning 27.0m. will be about 1.20m. deep. The purpose of multispan roof is to provide cover to floor

multispan roof is to provide cover to floor and give the required minimum clear height over the whole floor area with as few columns as practical.

9.9 THERMAL INSULATION

The usual practice is to provide an insulating layer on the soffit by laying fibre board or expanded polystrene sheets on the centering before the roofing sheet is placed. An alternative way of improving the insulation of the steel truss roof is to have a ceiling made up of plaster board.

9.10 PROTECTION AGAINST VIBRATION IN THE PRODUCTION HALL

For an accoustically satisfactory building, consideration must be given to mechanical services installations and technical equipments which may cause "Structure Borne Vibrations".

The following measures could be taken to prevent transmission of structure borne sound:

i. Provision of floating floors.

ii. Provision of acoustic mountings to all noise producing installations.

It is particularly important that insulating materials should not be bridged by solid parts.

Elastic Mountings must be able to function freely and where used in conjuction with machines, they should only be allowed to compress by a small part of their static loading. Satisfactory sound insulation can be achieved by floating floor construction, either by introducing an elastic and damping layer under the screed or under the floor battens. Best insulating materials are fibre glass quilts and mats of similar materials.

9.11 SCHEDULE OF ACCOMODATION

ADMINISTRATIVE DEPARTMENT	APPROXIMATELY AREAS(m^2)
Managing Director	6 x 5 = 30.00
General Manager	6 x 5 = 30.00
Company Secretary	4 x 5 = 20.00
Industrial Manager	5 x 4 = 20.00
Assistant Industrial Manager	5 x 4 = 20.00
Personnel Secretary	5 x 2.5 = 12.50
Executive Office(Administrative)	5 x 4 = 20.00
General Office	6 x 9 = 54.00
Conference Room	11 x 6 = 66.00
Reception Area	7 x 4 = 28.00
Store	4 x 6 = 24.00
Interviewing Area	8 x 6 = 48.00
Toilets/Stairs	8 x 6 = 48.00

PURCHASING DEPARTMENT	APPROXIMATELY AREAS(m^2)
Purchasing Officer	4 x 5 = 20.00
Assistant Purchasing Officer	4 x 5 = 20.00
Personnel Secretary	2.5 x 5 = 12.50
Marketing Officer	4 x 5 = 20.00

SALES DEPARTMENT	APPROXIMATELY ARE (m^2)
Sales Manager	6 x 5 = 30.00
Assistant Sales Manager	4 x 5 = 20.00
Sales Representatives	4 x 5 = 20.00
Personnel Secretary	2.5 x 5 = 12.50
Sales (Records)	4 x 5 = 20.00
Store Keeper	3 x 5 = 15.00
Drinks Restaurant/Servery	4 x 5 = 20.00

ACCOUNTS DEPARTMENT	APPROXIMATELY AREAS(m^2)
Chief Accountant	6 x 5 = 30.00
Accountant	6 x 5 = 30.00
Secretary	2.5 x 5 = 12.50
Supervisor of Accounts	4 x 5 = 20.00
Accounts (Records)	4 x 5 = 20.00

SOCIAL/WELFARE DEPARTMENT	APPROXIMATELY AREAS(m^2)
Public Relation Officer (P.R.O.)	4 x 5 = 20.00
Assistant Public Relation Officer	4 x 5 = 20.00
Welfare Officer	4 x 5 = 20.00
Dispensary	6 x 5 = 30.00
Waiting Room/Card	4 x 5 = 20.00
Secretary	4 x 5 = 20.00
Chief Security Officer	4 x 5 = 20.00

PRODUCTION UNIT	APPROXIMATELY AREAS(m^2)
Maintenance Officer	4 x 5 = 20.00
Production Manager	4 x 5 = 16.00
Production Supervisor	3 x 4 = 12.00
Assistant Production Supervisor	3 x 4 = 12.00
Laboratory	6 x 4 = 24.00
Main Production Hall	60 x 90 = 5400.00
Simple Syrup Room	15 x 9 = 135.00
Final Syrup Room	12 x 9 = 108.00
General Store	16 x 9 = 144.00
Sugar Store	15 x 18 = 270.00
Concentrates/Cold Room	8 x 10 = 80.00
Part I Concentrates Store	8 x 10 = 80.00

WORKERS' FACILITIES UNIT	APPROXIMATELY AREAS(m^2)
Restaurant or Canteen	9 x 15 = 135.00
Common Room	9 x 9 = 81.00
Kitchen/Stores/Kitchen Yaro/etc.	9 x 9 = 81.00
Changing Room(Males and Females)	5 x 4 = 20.00
Entrance Hall with Cloaking	5 x 4 = 20.00

AUXILLIARY DEPARTMENT	APPROXIMATELY AREAS(m^2)
Water Reservoirs	(5 x 4) x 4 = 80.00
Water Treatment Plant	16 x 9 = 144.00
Sanitary Engineer	3 x 4 = 12.00
Store	2.5 x 1.5 = 3.75
CO_2 Production Plant	4 x 6 = 24.00
Chemical Engineer	4 x 3 = 12.00
$CaSO_4$ Store	4 x 3 = 12.00
H_2SO_4 Store	4 x 3 = 12.00
$CaCO_2$ Store	4 x 3 = 12.00
Boiler Room	4 x 6 = 24.00
Oil Tanks Room	4 x 6 = 24.00
Store	3 x 2.5 = 7.50
Electrical Engineer	4 x 3 = 12.00
Transformer	5 x 6 = 30.00
Generator House	5 x 6 = 30.00
Diesel Room	8 x 6 = 48.00
Mechanical Engineer	3 x 4 = 12.00
Tools Storage	2.5 x 3 = 7.50
Mechanical Workshop	6 x 9 = 54.00

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