CENTRE FOR PHARMACEUTICAL RESEARCH

AND DEVELOPMENT, ZARIA.

CENTRE FOR PHARMACEUTICAL RESEARCH AND DEVELOPMENT, ZARIA

By

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A thesis submitted to the post-graduate school, Ahmadu Bello University, Zaria, Nigeria in partial fulfilment of the requirements for the degree of Master of Science in Architecture (M.Sc. Architecture).

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August, 1988

DECLARATION

I declare that this thesis is an original manifestation of my painstaking research endeavours and all sources of information have been adequately acknowledged. To the best of my knowledge, it has not been presented any where for any form of academic examination.

SADIQ, Ibrahim Bashir

CERTIFICATION

This thesis report entitled "Centre For Pharmaceutical Research and Development, Zaria" by Sadiq, Ibrahim Bashir meets the regulations governing the award of the degree of Master of Science in Architecture of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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Chairman, Supervisory Committee Date

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Member, Supervisory Committee Date

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Head, Department of Architecture Date

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Dean, Post-Graduate School Date

DEDICATION

To Allah

for His infinite mercies

To my Parents

for their love and understanding.

PREFACE AND ACKNOWLEDGEMENT

The First Instinct of an Architect when he is asked to design a building is to enquire into its purpose.

The detailed of the requirements for a specialised research centre of this nature are outside the common experience of anybody other than the specialist themselves. The architect therefore needs to become sufficiently acquainted with what is going on in these research centres, to enable him provide suitable spaces and condition for the people to use them.

Consequently, for the technical and special aspect of this thesis, I relied very much on information from people, books and magazines I could lay my hands and such information is duly acknowledged.

However, special mention must be made of the considerable amount of information I received from Dr. Abdul Ghani, Head of Department of Pharmacognosy, Ahmadu Bello University, Zaria and Dr. A. Odutola of the same Faculty. I am grateful for your interview and lectures. I am also grateful to some Scientists at Institute of Chemical Research and Technology, Zaria for granting me interview and conducting round their laboratories. My thanks also goes to Professor Sofowora Abayomi who, though I was unable to meet personally but his books and publications in this topic provided a good head start.

I am deeply indebted to my mentors Dr. F. W. Schwerdtfeger and Arc. Fred Ado for their detailed guidance and contribution by way of suggestion and criticism. Similarly I am grateful to my colleagues especially Bayo Fahm, Basil Odumah and Mukaila Oyewole for their suggestion at the planning stage of the thesis.

My immense gratitudes goes to my parents, especially Alhaji Sadiq for his moral and financial support. My thanks also goes to my relatives and friends who help me throughout the difficult period.

Above all, I am grateful to Allah for His mercies and love which has enable me to achieve this objective.

ABSTRACT

Introduction

The struggle for the overall development of Nigeria nation depends largely on the role of science and technology.

One area which Nigeria like any other third world country must constantly focus its attention is how to accelerate its development, so as to improve the quality of life of its citizen and also to achieve national greatness.

The major area of attainment of this goal is its ability to achieve its self-reliance policy. It must consider the acquiring and building up of technological skills and knowledge very fundamental and imperative. This required skill and first-hand knowledge can only be acquired and developed through elaborate and well-sustained research.

However, it needs to be appreciated that just as very little can be achieved by any one who is physically and mentally impaired, so also can no country raise its level of productivity, if the dictum that "Health is wealth" is not fully taken into account.

The World Health Organization recently launched its "Health for all by the year 2,000", to be achieved by all member nations of the world. In order for Nigeria to achieve this objective, the government

needs a lot of foreign exchange which are not available for the importation of drugs. But with the availability of various raw material especially herbs of various medicinal use and for the fact that majority of rural populace depends on this for their health. The need to make proper research into local raw material of medicinal values becomes imperative.

It is here that a Centre for Pharmaceutical Research and Development comes in. Long overdue, such research centre will contribute immensely to every aspect of pharmacy in the country. In the area of research into traditional medicines, there is no doubt that there is a rich source yet untapped.

Goals

The basic goal of the Research Centre is to make research into the medicinal use of various material, especially herbs that are found in Northern Nigeria and possible integration into modern medical practice. The thesis goal therefore is to provide an architecture compatible with the programme requirements and sympathetic to socio-cultural and climatic environment.

Objectives

Provision of functional space for an efficient and quality program execution. A pleasant and stimulating atmosphere sensitive to environmental conditions. An

architecture which provides for flexible and adaptable use of spaces.

Scope

The thesis will be limited to administrative, information and research areas of the research centre which usually encompasses staff accommodation, production and supporting facilities.

Conclusion

It is hoped that a successful architectural programme may evolve which will take into consideration the successes and avoid the failures of the various research centres.

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Chapter 1

THE NEED

1.0 INTRODUCTION

In recent years, Research Institutes have been established with the aim of studying various subjects and using the results to improve the lot of the people. Research Institutes have been established in the social sciences, industry and chemicals, with the aim of refining a specific subject matter that will be of specific need in the country's development. Some of these Institutes have been able to fulfill the objectives set for them while some might have to be merged, revived or striffled.

Considering the quick need of a smooth technological take-off some other Research Institutes might have to be established. One of such areas where more research need to be initiated is the health field.

When the "Basic Health Scheme" was launched about a decade ago, the main objectives was to bring basic medical treatment to a target of about six per cent (60%) of the country's population. More recently the slogan has become "Health for all by the year 2,000" by which time our population according to experts is being projected to reach 120 million. The corrolary to this slogan is the provision of basic drug needs for the projected 120 million people of the country by the year 2,000.

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ZARIA, NIGERIA.

Most of our drug needs were and are still being imported with the boom years gone, our dwindling foreign earnings have limited foreign exchange availability for the importation of foreign goods leading to acute shortage of drugs in the country. Available data indicate that over 75% of our drug needs are being imported, there is no doubt that we can only achieve our objective of self-reliance by reversing this trend by establishing a research centre for utilizing our resources for drug production locally.

1.1. History and Assessment of Scientific And Technological Research in Nigeria

Research activities in Science and Technology started during the colonial era under the British West African Research Institutes. The noticeable ones in Nigeria include West African Institutes For Oil Palm Research (W.A.I.F.O.R.) with headquarters in Benin, West African Institute for Social and Economic Research (W.A.I.S.E.R.) with headquarters in Ibadan and West African Stored Products Research (W.A.I.S.E.R.)[1] with headquarters in Lagos. These Institutions are for corroborative research in the then British West African Colonies of Gambia, Sierra-Leone, Ghana and Nigeria. After 1957 there was a break-up of these research Institutes into National Institutions due to the attainment of Independence. The establishment of Institutions of higher learning in Nigeria marked the

beginning of a new era in research work, especially in basic research as the University is traditionally the craddle of research and knowledge.

In order to keep scientists in the various Institutes in touch with one and another a voluntary society called "Science Association of Nigeria" was formed in 1958. The association publishes the "Directory of Scientific Research in Nigeria" to highlight research work and indicate the various scientific interest in the Universities and Research Institutes[2].

For almost ten years after independence Nigeria lacked an official national sense of direction in the field of science and technology, until the Federal Military Government enacted Decree No. 6, establishing the Nigerian Council for Science and Technology (N.C.S.T.) in February, 1970. Functions of these council included the determination and advice to government on National Technological policy and the co-ordination and promotion of scientific activities in the country. Fields covered by N.C.S.T. then were:[3]

(a) Agricultural sciences
(b) Experimental sciences
(c) Industrial sciences
(d) Medical sciences
(e) Environmental sciences
(f) Social sciences

The research institutes in existence then include the following:

(1) International Institute of Tropical Agriculture (I.I.T.A.).
(2) Nigerian Institute for Social and Economic Research (N.I.S.E.R.)
(3) National Institute of Medical Research
(4) Nigerian Institute for Oil Palm Research
(5) Nigerian Institute for Trypanosomiasis Research
(6) Cocoa Research Institutes of Nigerian.

All these institutions were under the corresponding Ministries which also controlled their budgets and the condition of service of the researchers who are often lost to the Universities. Co-ordination of the work of the council was difficult and ineffective. It lacked executive powers being essentially only advisory. The composition was unwieldly and lacked cohesion because it include representative of disciplines, ministries and states.

A situation was eventually reached which led "to the establishment of an autonomous National Science and Technology Development Agency" (NSTD) with a representative in the Federal Executive Council unlike the Nigerian Council for Science and Technology, its predecessor. The Agency (NSTDA), established in 1977 as an autonomous body has six departments for Agricultural sciences, Medical sciences, Industrial sciences, Natural sciences as well as Planning and Administration.

The functions of National Science and Technology Development Agency includes the following:

(a) To advise the Federal Government on National Science policies and priorities and on scientific and technological activities generally.

(b) To prepare periodic master plans for the development of science and technology and advise the Federal Government on the financial requirements for implementation of such plans.

(c) To advise the Federal Government on the creation of new research institutes and centres and the reorganisation of existing ones to meet national needs.

(d) To supervise and co-ordinate the activities of research institutes and centres.

(e) To take such steps as it may deem necessary to facilitate the application of the results of scientific and technological research by Federal and State Ministries and their agencies.

(f) To publish or sponsor the publication of scientific research journal as it may consider desirable.

(g) To channel external aid meant for the development of science and technology to government research establishment.

(h) To carry out such other activities as are necessary or expedient for the full discharge of any of the functions of the agency[4].

By October 1979, the Federal Ministry of Science and Technology was created and all functions of N.S.T.D.A. was transferred to the Ministry. Presently there are twenty three (23) research institutes in Nigeria which are all under the Federal Ministry of Science and Technology. Among these 23 research institutes none of them is engaged in pharmaceutical research.

1.2. Motivation

One of the major reasons for the establishment of a "Centre for Pharmaceutical Research Centre" in Nigeria is the need to conserve foreign exchange by ultimate reducing importation of drug through encouragement and stimulation of local drug production. At present, barely 20% of all the drugs consumed in this country is produced locally[5]. Only secondary drug production is done here, that is, even the raw materials used for the 20% production are imported. A Pharmaceutical Research Centre will provide local substitutes for many drugs that are imported.

Almost all the important pharmaceutical industries in the country are "operationally controlled" by the big multi-nationals. These organisations carry out research in the development of new drugs in the laboratories of their parent companies or associates in the developed countries. Consequently, little or

no significant research is being carried out by the pharmaceutical industries in Nigeria to develop new drugs. Apart from the economic advantages of the parent companies carrying out research in their home laboratories, lack of adequate infrastructural facilities and supporting industries, low standard and high cost are not encouraging to these industries.

Traditional medicine is used by 75% or more of the total population of Nigeria as the only available form of health care in their neighbourhood. Improvement of the methods and medicaments used by traditional healers through research into their herbs is bound to yield new sources of drugs and richer sources of already known drugs. The local concoction used by the traditional healers could also be evaluated in order to develop them, improve their efficacy, safety, availability and wider application.

A lot of drugs used in modern medicine today, like digoxin, the antimalarials, atropine, caffeine, morphine, ergometrine, cocaine, etc; derive their origin from plants (Sofowora, 1982) then the need to make more research into Nigerian plants for drugs become apparent. This is very important for Nigeria because although the drug plants abound in large quantities, drug available in the hospitals, or dispensed in our pharmacies amount to less than 5% from plant sources (Sofowora, 1982) whereas in U.S.A. drugs of plant origin utilised in public pharmacies

amount to 25% of total number of prescribed drugs. Research into plant drugs at regional level would open up more plant drugs that can be incorporated into official health care delivery in Nigeria and this is best done at a centre for Pharmaceutical Research, working at all aspects of drug development.

There is need to standardise the plant drugs used in traditional medicine and have these available in suitable dosage forms for use. The research, required needs the bringing together of expertise scattered about in our country at present including Chemists, Biologists, Physicians, Pharmacologists and Toxicologists. A Pharmaceutical Research Centre bringining these experts together would allow for a quick upsurge in the developments of new drugs from plant.

The proposed petrochemical industry has long been expected to reduce the importation of some pharmaceutical raw materials like terephthalic acid, phthalic anhydride, benzene, formaldehyde, methanol and so on (7). But the advent of these raw materials has now been put to the third phase of petrochemical industries. Such an industry needs a complimentary pharmaceutical research centre to research into new local uses for these petrochemicals in the pharmaceutical field so that the demand for products

of that Petrochemical Industry could be maximised (Olaniyi, 1983).

The establishment of a Pharmaceutical Research Centre would lead to a better co-ordination of researches being carried out in the Universities. Besides, such a Research Centre would attract scientists from within and outside Nigeria for intensive research for short and long visits.

The new findings from research at the proposed research centre on synthetic or natural drugs will stimulate local pharmaceutical industries to exploit the findings commercially. Through a Pharmaceutical Research Centre there is no doubt that the positive effort to be derived in boosting local drug production with the ultimate reduction on importation on drugs will lead to savings in foreign exchange.

The establishment of a pharmaceutical research centre would reduce the tendency of pharmaceutical firms to send every research problem to their parent company abroad when they find out that adequate expertise that can tackle the problem in multi-disciplinary fashion now exist in the country.

A look at the money invested into drug importation show that in 1981, the total cost of drugs imported into Nigeria amounted to ₦185,113,463.34 (8). In 1982, because of drastic cuts due to austerity measures,

Nigeria still imported drugs to the tune of ₦169,402,606.80. The size of these expenditures on importation of drugs will be appreciated more when it is considered that they are higher each year than the total budget of the Federal Ministry of Health which was only ₦153,437,434 in 1981 and ₦55,808,280 in 1982. Yet, the cost of drugs keep rising and our foreign expenditure on drugs fetches less and les for us, in termsof value for money. This current rising cost of drugs, which continues to be sizeable proportion of the Health bill for our Federal and State Governments, makes it imperative to make investment in a pharmaceutical research centre in order to encourage a better use of local raw materials so as to cut down drastically the cost of drugs (9).

Several other reason could be advanced for the establishment of pharmaceutical research centre but suffice it to say that 33% of total drugs produced by industrialised nations from whom we import our drugs are plant-derived and that if microbes are added, then 60% of medicinal productions are of natural origin (10). Higher plants have, in fact, been described as sleeping giants of drug development even in U.S.A. (11). A digest of plants that can be cultivated for drug production in Nigeria has already been complied by botanist and ready for use (12). Since we have these higher plants in abundance here in Nigeria, we might

as well start using them to produce the very medicinal agents that other developed countries use then for. This can be achieved through coordinated research efforts at a Research Centre geared towards stimulating drug production in Nigeria. Such efforts will augment the standardisation of herbal remedies such will pave way for incorporation of traditional medicine into official health care delivery system as well as improve manpower developments of pharmacists, chemists, and allied expertise needed in drug development and health care delivery.

1.3. Aim and Objective of Centre for Pharmaceutical Research and Development

A Pharmaceutical research which aims at producing drugs from local raw materials must be multi-disciplinary in approach and objective must be set for the team of researchers. Among the objective which Sofowora (has rightly pointed out could be broadly spelt out as follows:

1. To search for new drugs and pharmaceutical particularly for tropical diseases from local materials and by synthesis.
2. To carry out research and development into pharmaceutical utilisation of local raw materials.
3. To develop new or improved quality control methods for pharmaceuticals used in Nigeria.

4. To translate research findings into viable pharmaceutical projects in collaboration with appropriate government agencies.

5. To act as data bank of National Reference standard of pharmaceuticals.

6. To act as a forum for contact and dissemination of information on drugs.

7. To carry out technical and consultancy services on drugs for local pharmaceutical industries, individuals and government establishments.

1.4. Functions of the Centre for Pharmaceutical Research and Development

The objectives specified above for the Centre as well as the points made under justification give a good indication of the type of functionsthe centre could perform. The priority of the centre with respect to research would vary, however, from time to time depending on the development stage of pharmaceutical services in this country as well as prevailing problems posed by the economy with respect to pharmaceutical industry in Nigeria.

The functions could be broadly spelt out as follows:

a. To identify potential and priority areas of basic and applied research, for the ultimate purpose of achieving national self-sufficiency.

b. To initiate and co-ordinate all scientific investigations on medicinal plants as well as promoting and mobilising their applications with view to maximising research output while minimising duplication of research efforts.

c. To liaise with traditional healers and herbalists, for the purpose of research and development of Nigeria's traditional medicinal plants as drugs.

d. Encourage team effort in research and making adequate arrangement for carrying out careful evaluation, with particular reference to standardisation, dosage forms, efficacy, toxicological studies and quality control of products obtained from medicinal plants and other sources in Nigeria.

e. To exploit locally derived chemicals and raw materials in the production of pharmaceuticals.

f. To identify and co-ordinate the resources and seeking financial support from the pharmaceutical industries, governments and international agencies like WHO, UNIDO, UNESCO, OAU/STRC.

g. Liaise with industries, allied establishment and individuals, for the purpose of taking patents for the commercial production of drugs, pharmaceutical raw and packing material.

Others are:

h. Consultancy. The Centre for Pharmaceutical Research and Development is also expected to perform consultancy services to pharmaceutical industries and other allied establishments.

i. Scientific information. The centre will embark on the monitoring and documentation of scientific information within and outside the country with the aim of popularizing and publicizing science and pharmaceutical research and making available all the useful aspects of it.

j. Co-ordination. The Centre will serve as co-ordinating link for scientific/industrial, it may establish a satellites institutes or sponsor in the national universities.

k. Conferences. The centre would be expected to organize and host a number of national and international conferences, symposia and workshops to promote the exchange of ideas and knowledge.

1.5. Liaison With Other Research Institutes

The Centre for Pharmaceutical Research and Development will need to liaise with other existing and planned National Research Institutes for the execution of some of its projects especially those involving plants. For this reason, when a drug reaches

clinical trials stage, the Nigerian Institutes for Medical Research will be involved. The Institute would also liaise with the Nigerian Institute for Chemical Research, the Petrochemical industry and especially with the proposed National Research Development Corporation (NRDC) for the commercialisation of the product of its research. Since the NRDC is yet to materialise, in the interim, the Centre would liaise with National Office of Industrial Property for patenting its findings. The table attached shows the various existing Research Institutes as well as the specific projects they carry out in which the proposed Centre would be interested (13).

Other Research Institutes Which the Proposed Centre for Pharmaceutical Research Will Liaise Showing the Specific Projects of Interest (14).

Name of Institute	Project Title	Project Description
National Institute for Chemical Research	Research and development of industrial and allied chemicals.	Under the project laboratory facilities will be built for the development of industrial and allied basic chemicals including acids, alcohols, dye-stuff, synthetic chemicals, pesticides, and so on.
Federal Institute for Industrial Research (FIIR)	Research and development of post harvest technologies for industrial processing of local food stuffs.	The local foods concerned are local cereals, fruits, vegetables, roots and tubers and various meat and fishery products. Activities will include: identification of new indigenous technologies: upgrading,

Name of Institute	Project Title	Project Description
		modification and modernization of the existing local food technologies.
	Food Science and Research and Development	Research will be carried out into the evaluation and improvement: of nutritional value of Nigerian local food crops and developing new processed foods to pilot plant scale from local crops, fruits and vegetables.
	Development of Industrial technology for processing of cereal in the semi-arid zones of the country.	Activities under this project will include processing of cereal (maize, millet, guinea-corn, acha) and development of outstation facilities.

Name of Institute	Project Title	Project Description
Rubber Research Institute of Nigeria	Research into commercial utilization of the Rubber Tree	This will involve studies on the use of the rubber tree as timber, for pulp manufacture, paints vanishes and cosmetics. The rubber seeds are also usable as livestock feed.
Cocoa Research Institute of Nigeria	Improvement of Kola generic potential and storage	This project aims at producing and distributing high yielding kola cultivers to replace existing low producing and sterile kola groves. Research will also be carried out into ways of including, dwarfing, flowering and fruiting and biology and ecology of the economic pests and diseases. Investigations will be carried out on other possible uses of kolanut and its by-products.

Name of Institute	Project Title	Project Description
Nigerian Institute for Trypanosomiasis Research	Development and production of Vaccine against sleeping sickness and river blindness	The project aims at massive cultivation of infective stages of trypanosomiasis species in the laboratory for possible production of vaccines for the use of both man and animals.
Institute for Agricultural Research, Zaria	Cowpeas and soya bean improvement project.	The project involves research into ways of improving the yield of cowpeas, soyabeans, bambarra nut, hariot beans and lima beams. It will be executed in collaboration with National Cereals Research Institute.

Name of Institute	Project Title	Project Description
National Veterinary Research Institute	Vaccine Production Unit	Project involves building construction, equipment and staffing of the vaccine production unit. The aim of the unit will be to maximise vaccine production.
National Root Crops Research Institute	Cassava Improvement Studies	The project aims at the development of packages of improvement technology which will minimize losses due to cassava pests and diseases and raise yield by up to 300 per cent. Problems of poor management and drugery of production will also be examined.

Name of Institute	Project Title	Project Description
	Yam Improvement Studies	The project is aimed at solving the problems of the farm-gate processing, storage and the preservation of yams. The aim is to achieve a 50 per cent production in seed yam costs increase in yields, 50 per cent reduction in storage and 60 per cent reduction in labour requirements.
Nigeria Stored Products Research Institute	Improvement Storage of Oilseed and Oilseed Products	Studies will be conducted into the existing methods of oilseed and their cakes. New methods and techniques of quality maintenance will also be investigated and utilised.

Name of Institute	Project Title	Project Description
Leather Research Institute of Nigeria	Utilisation of Animal and Leather by products	The project aims at converting what is now regarded as "Wastes" in slaughter houses and tanneries into "Wealth" by organising the general collection of the by-products and processing them for commercial utilization. These by-products include blood, bone, hoofs, etc., while tannery by-products include trimmings, fleshing, pulp, and so on.
National Cereals Research Institute	Mangrove Rice Cultivation	The project is to develop high yielding, disease and pest resistant rice, varieties for the mangrove tidal flats of Nigeria.

	Improvement of Maize Production Methods	The project aims at developing hybrid maize for cultivation in high altitude zones, acid soil zones and mildew epidemic areas.
National Horticultural Research Institute	Improvement of Vegetables	The project is aimed at the improvement of 10 nationally important vegetables, 7 regionally important vegetables and 4 important exotic vegetables. The research will include the development of improvement lines of vegetables and weed and pests control.

Name of Institute	Project Title	Project Description
	Improvement of Fruits	The project involves the improvement of 15 nationally important fruits, 4 regionally important fruits and 4 nationally important fruits. Research studies will ascertain the effects of various cultural and management practices of their production performances and ensure resistance to diseases.
Institute of Agricultural Research and Training (IFE)	Development of Integrated Farming for Food production for small-scale farmers.	The project aims at investigating ways of improving the technology for the production of cereal and legume food crops and vegetables in an integrated farming system. Such system when developed will be adopted in South Western Nigeria.

Name of Institute	Project Title	Project Description
National Institute for Medical Research	Study of Major Non-Infective Diseases	Studies will include those of synergism between malnutrition and infection, nutritional and metabolic disease, maternal nutrition and outcome of pregnancy and other nutritional and malnutritional diseases, foods quality, etc. They will also include sickle cell Anaemia Research.
	Traditional Medicine Research	This involves multidisciplinary investigations into systems of traditional medicine with special emphasis on laboratory and clinical plants, animal products and mineral substances (14).

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Chapter 2

PHARMACEUTICAL RESEARCH
GENERAL CONSIDERATION

2.1. Concept of Research Types

Research is basically referred to as a venture into the unknown. Research is also an intensive study for advancement in very many areas of knowledge.

The path into research is divided into two main categories, viz:

1. Basic Research
2. Applied Research

Basic Research

This attempts to uncover new scientific knowledge and understanding with little regards as to when or how the new facts will be used.

Applied Research

This is conducted with a specific purpose in mind. It is directed towards specific problem or towards a series of problems that stand in the way of progress in particular area.

Applied Research is concerned with the discovery and application of scientific knowledge to particular problems with the aim of uplifting the ways and means of finding new things that will make life better for man, e.g. discovery of new drugs.

Nevertheless, basic and applied research are not isolated fields as they are highly dependent on each other. Applied research has being in most cases based on the findings of basic research likewise development is based upon solutions that applied research has worked out for problems relating to specific cases of methods.

"The engineering aspects of research have come to be known as development, which is the systematic use of research for design and production of materials, devices and prototypes or for the organising of methods processes, and systems for production". Development is therefore the essential link between Basic and Applied Research and their industrial application - hence, the chosen title "Centre for Pharmaceutical Research and Development" for this thesis.

2.2. Research Trends in Medicinal Plants and Traditional Medicine in Nigeria

Research works into plants and traditional medicine in the past was unco-ordinated and was not applied oriented. Chemist, pharmacologist and biochemist were more interested in isolating and characterizing organic

compounds from plants than in discovering whether such plants had biological activity or not (2).

There was change in approach after the first Organisation of African Unity's Scientific Technical and Research Commission (OAU/STRC) symposium on plants and traditional medicine held in Dakar in 1968. The OAU/STRC started co-ordinating and financing research works into plant and traditional medicine being started by members states. It also zoned Africa into five zones with Ife and Dakar serving as centres for West African zone. The main objective of the research work was that of applied oriented. The recommendation was concerned with therapeutic and efficacy of plant and traditional medicine (3).

A multi-disciplinary approach to research was adopted involving pharmacologist, pharmacognosists, chemist and botanist. The Drug Research and production Unit of Obafemi Awolowo University, Ile-Ife was designated the research centre in Nigeria.

By the year 1979, research works were concentrated on isolation of bioactive agents from medicinal plants by monitoring the purification steps by bioassay. Documentation of traditional medical recipes was also initiated (1). Traditional healers were employed as consultants (as in the Pharmacognosy Department, Ahmadu Bello University, Zaria).

Researches were also carried out by other Universities especially those with Pharmacognosy Departments. These universities are Lagos, Ibadan, Nsukka, Benin and Ahmadu Bello University, Zaria. Most of their researches are however, not fully applied oriented and are uni-directional in nature, that is they are concerned with biochemical analysis of medicinal preparations from plants and animal (5).

The metaphysical aspect of traditional medicine remains untouched because it lacks scientific ways of proving it. There is however no co-ordination of research activities between these institutions.

2.3. Development of a New Drug

The development of a new drug may be either planned or deliberate. It is however known that serendipity, that is, unexpected finding of the potential utility of a compound, constitutes about 50% of all scientific break-throughs (6).

In general, three approaches are followed in the search for new drug agents (7).

a. The general screening approach in which chemical substances from natural or synthetic sources are tested for their effects against a pre-determined disease state.

b. The chemical modification of existing drug substances whose biological effects are known.

c. Mimicking nature in biochemical design where a compound is made to exert action in a manner similar to a known biochemical substance. Any "lead" compounds obtained from these three approaches are usually further modified chemically to gain biologically most potent representatives of the series.

Three main issues have been identified in drug development. These are: safety, efficacy and manufacturing. Safety must be proven first in animals before a drug is permitted to be used in humans. Then the safety must again be proven in humans to justify long term clinical rather than experimental use of a drug. This is followed after the drug has been approved for marketing, by investigations which will search for rare side-effects in those patients who have used the drug. Finally, the drug, after appropriate formulation into requisite dosage form, is manufactured with careful quality control so that each individual dose of medication will exhibit the high standard of safety and efficacy expected.

2.4. Extraction of Drugs

Extractives are pharmaceutical preparations obtained from plant and animal tissues with the aid of solvents and standardized extraction procedures.

Principal modes of extraction employed in pharmacy at present are as follows:

1. Maceration
2. Percolation
3. Digestion
4. Infusion
5. Decoction

Maceration and percolation are the officially accepted methods for the removal of active ingredients.

Extracts from plant find wide use in phytochemical and biochemical research, forensic, chemistry, and extraction of volatile oils.

Maceration - of ancient origin, consists simply of extraction by soaking the properly comminuted drug or substance in menstrum until the cellular structure is thoroughly penetrated and the soluble partions are softened and dissolved.

Usual method is to introduce the drug into a bottle with the solvent or menstrum, stoppet it tightly and agitate it occasionally for a period ranging from 2 to 14 days, pours off the liquids, express the residue to avoid losses and filter the mixed liquids.

An advantage is sometimes gained by suspending the ground drug, tied in a bag, in the upper part of the menstrum. The drugs are macerated in definite quantities of menstrum which consists of alcohol, of various strengths. Evaporation during filteration is to be avoided as much as possible. Maceration can be

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carried out by unskilled personnel since it is very simple process. Maceration is usually conducted at a temperature of from 15° to 20°C.

Percolation - is the extraction process in which a granulated or powdered drug is deprived of its constituents by the descent of a suitable solvent through it.

Solvents that can be used in the extraction process includes:

1. Water
2. Alcohol
3. Ether
4. Chloroform
5. Light petroleum
6. Glycerin
7. Acids
8. Fixed oils
9. Propylene Glycol

Properties of Ideal Solvent

1. Selective
2. Therapeutically inert if solvent is not to be completely removed.
3. Low boiling point if to be removed.
4. Pleasant odour and taste.
5. Cheap
6. Non-inflammable.

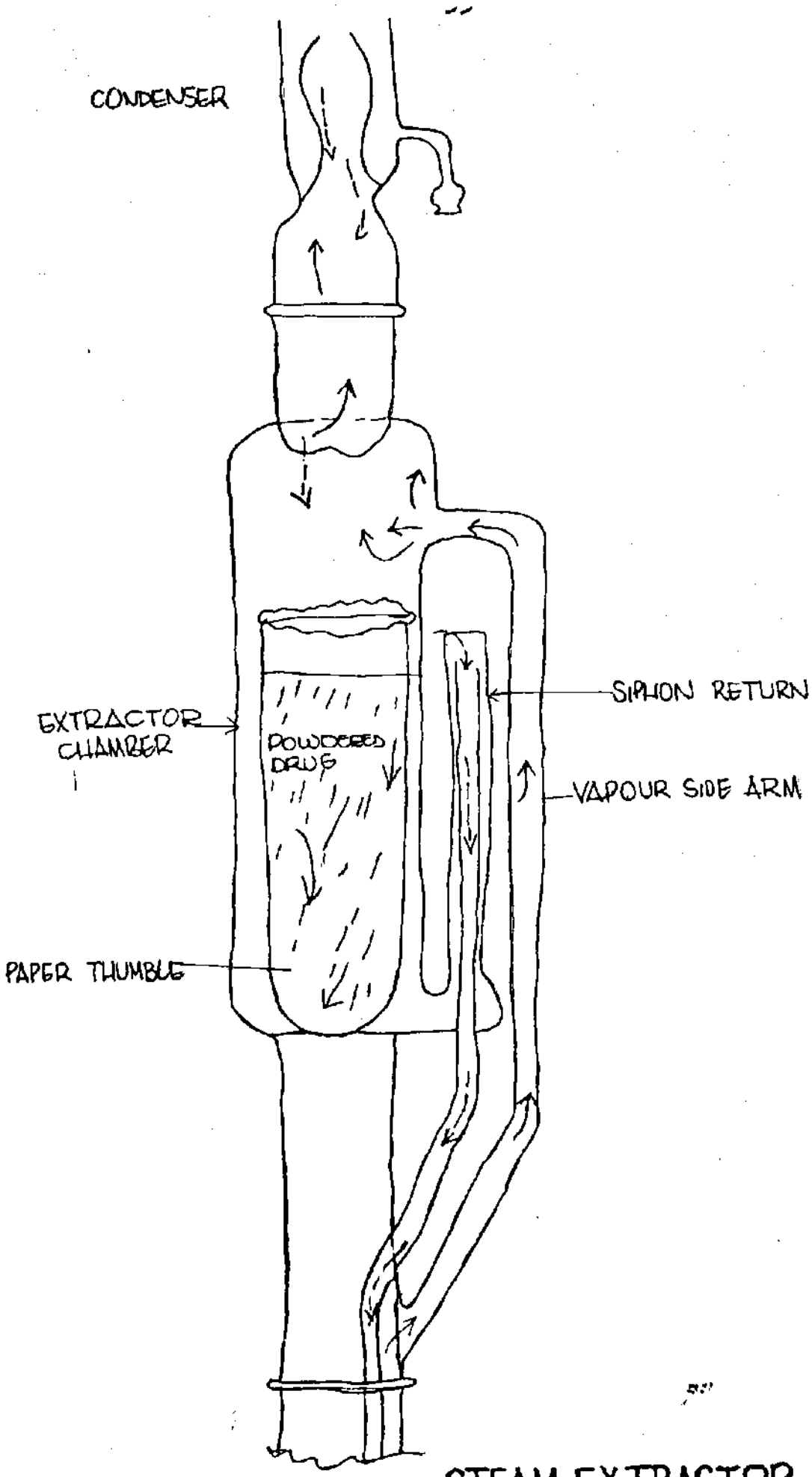


FIGURE 2.1 STEAM EXTRACTOR

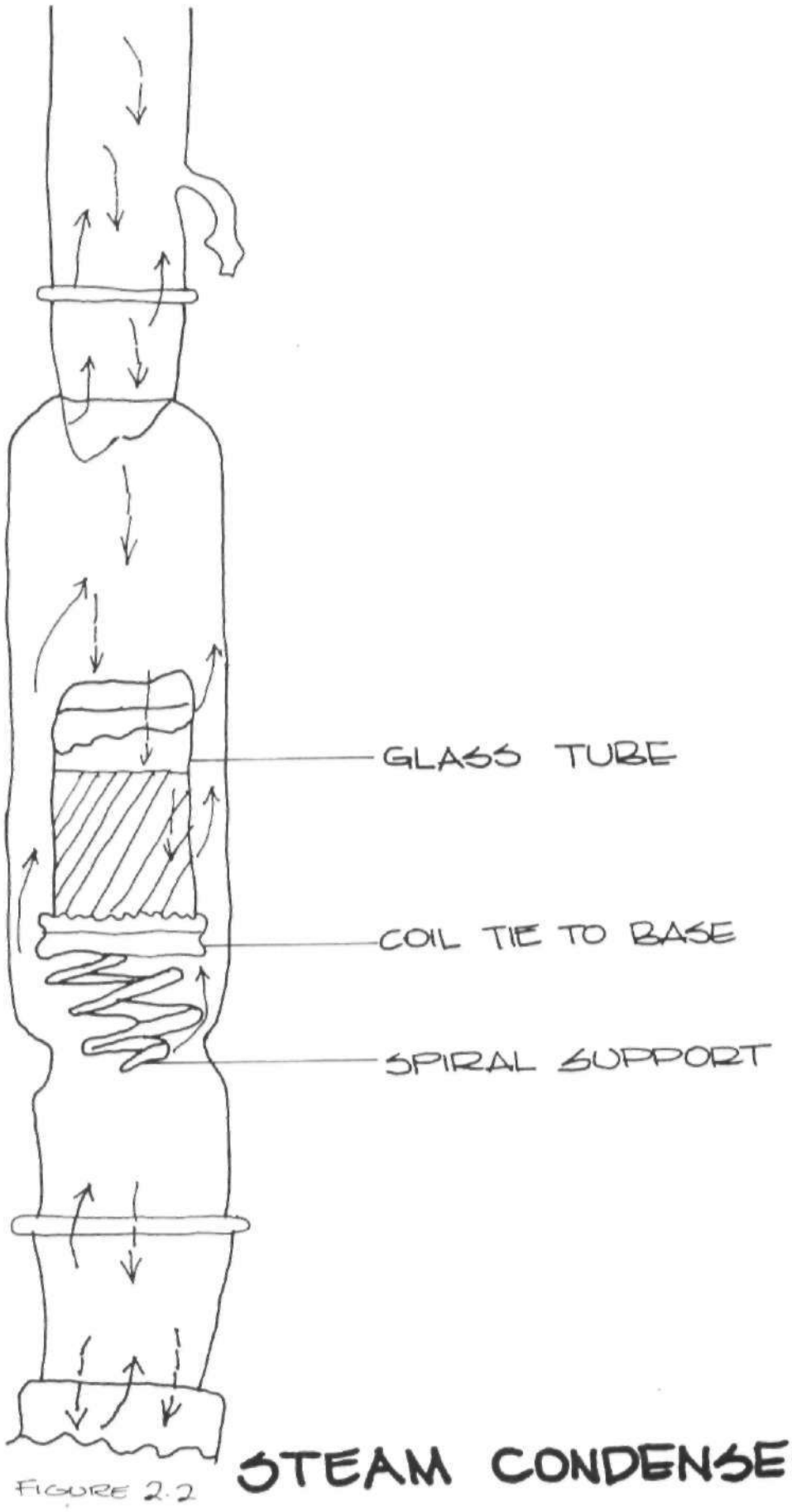
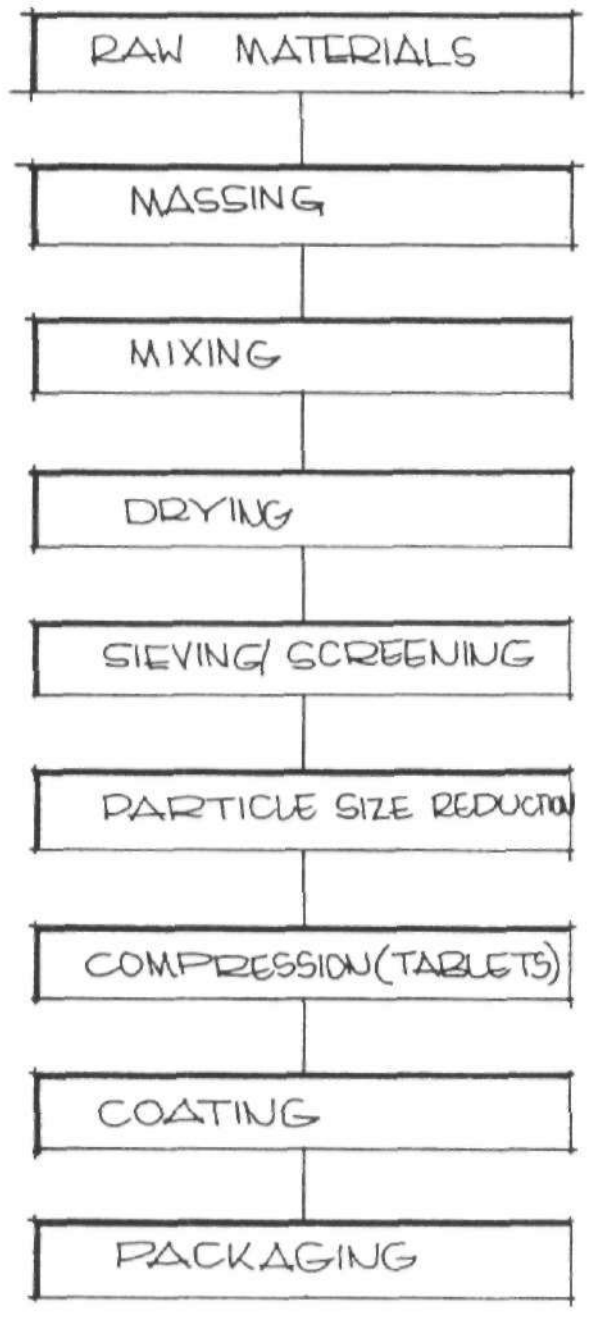


FIGURE 2.2 STEAM CONDENSER



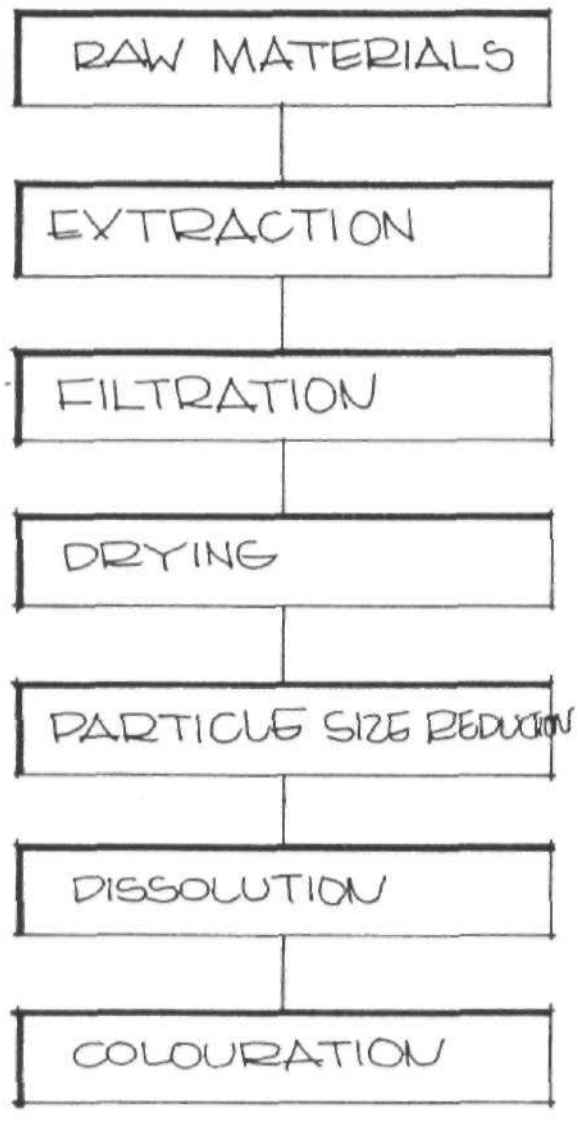
PROCEDURE EMPLOYED IN TABLET PRODUCTION

Fig. 2.3



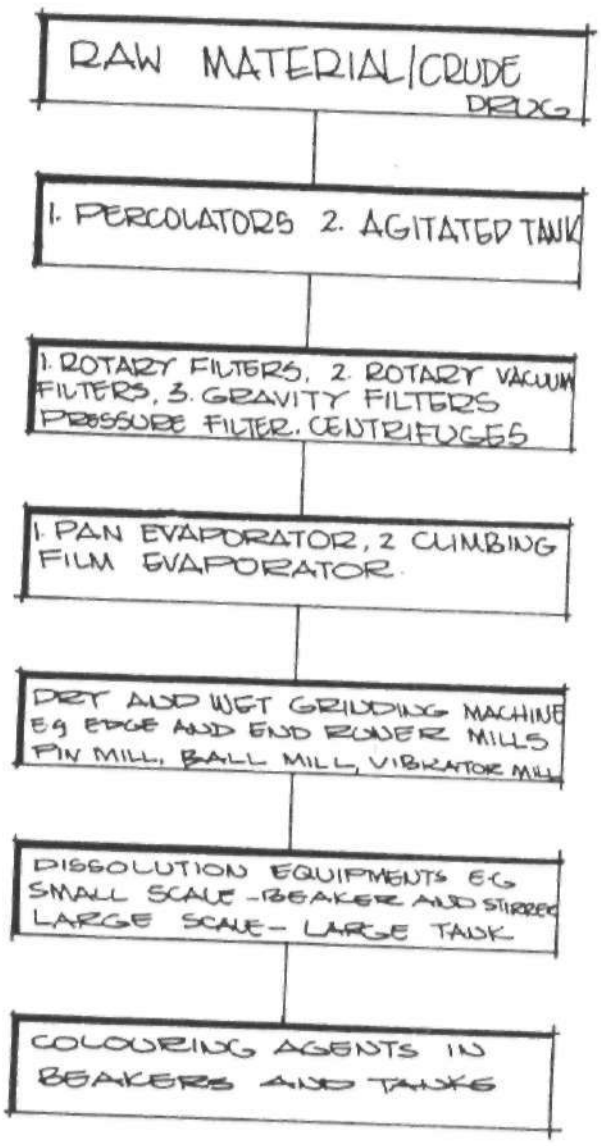
HARDWARE SYSTEM EMPLOYED IN TABLET PRODUCTION

Fig. 2.4



PROCEDURE OF PRODUCING LIQUID DRUG

Fig. 2.5



HARDWARE SYSTEM EMPLOYED IN LIQUID DRUG PRODUCTION

Fig. 2.6



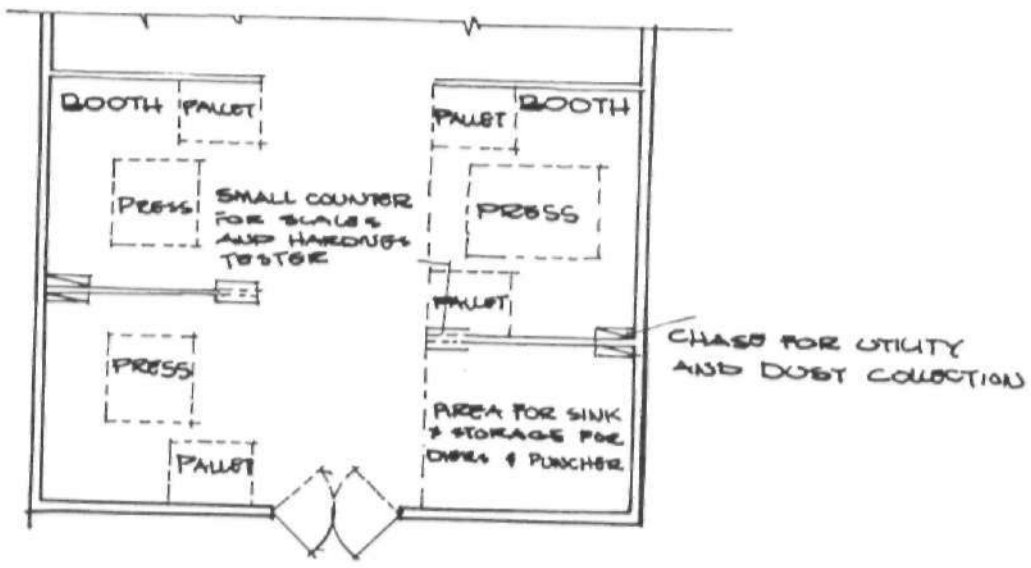
U-SHAPED - LINES SHOWING BOTTLES & CASE HANDLING EXTERNAL TO PACK ROOM

AISLE

PACKAGING ROOM SCHEMATIC

Fig. 2.7

U-SHAPED LINES WITH BOTTLE FILLING



COMPRESSING ROOM SCHEMATIC SHOWING OPEN BOTH ARRANGMENT

Fig. 2.8

TWO BOOTH SIZES DESIGNED TO ACCOMODATE ROTARY PRESSES

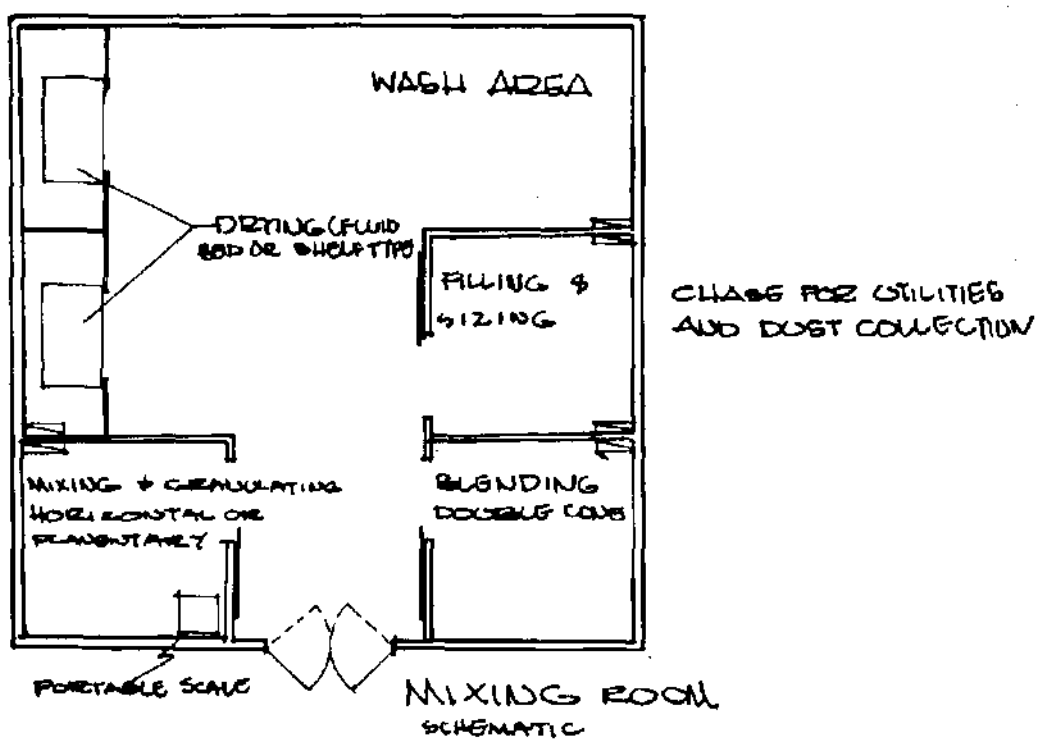
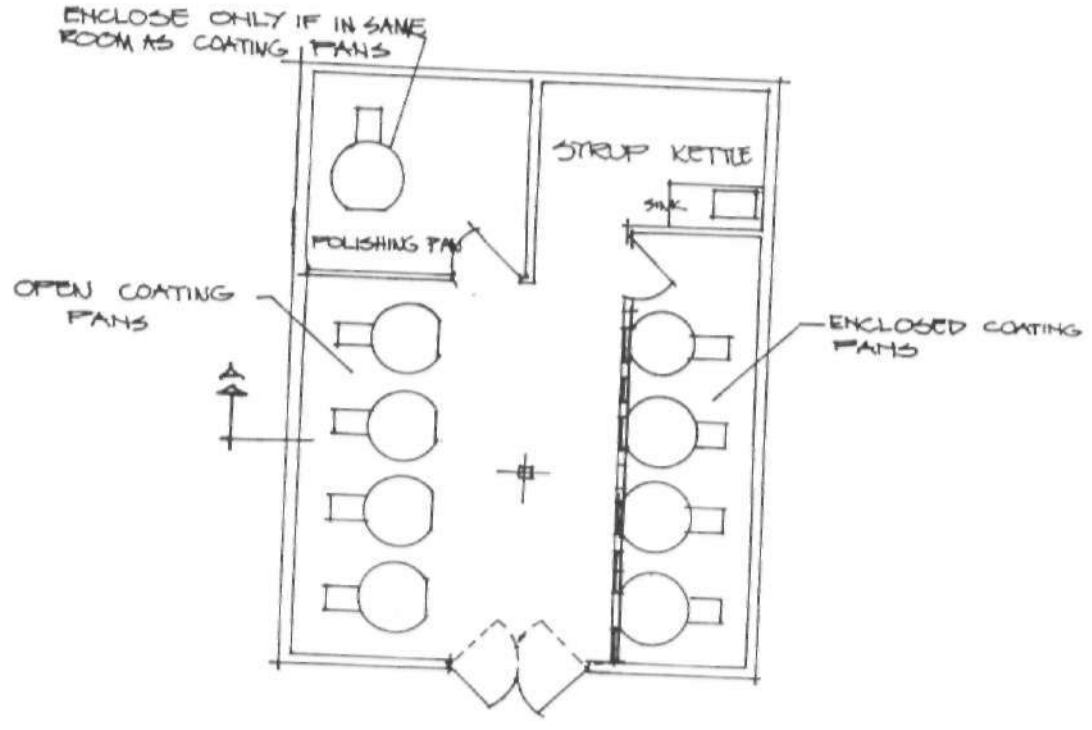
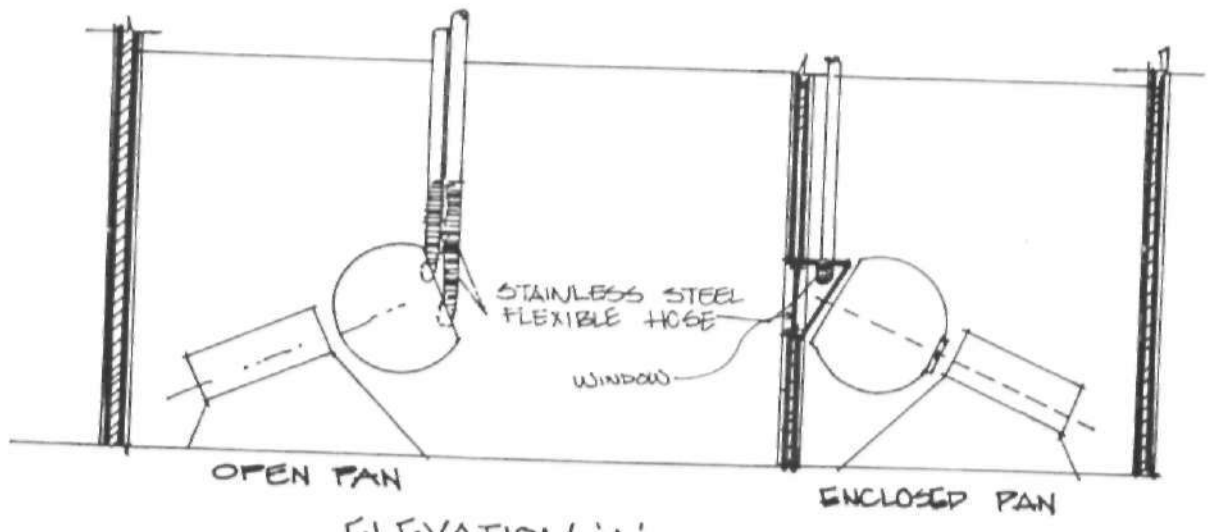


Fig. 2.9

TYPICAL GRANULATING ROOM SHOWING SEPERATION OF MILLING, BLENDING AND GRANULATING AREAS



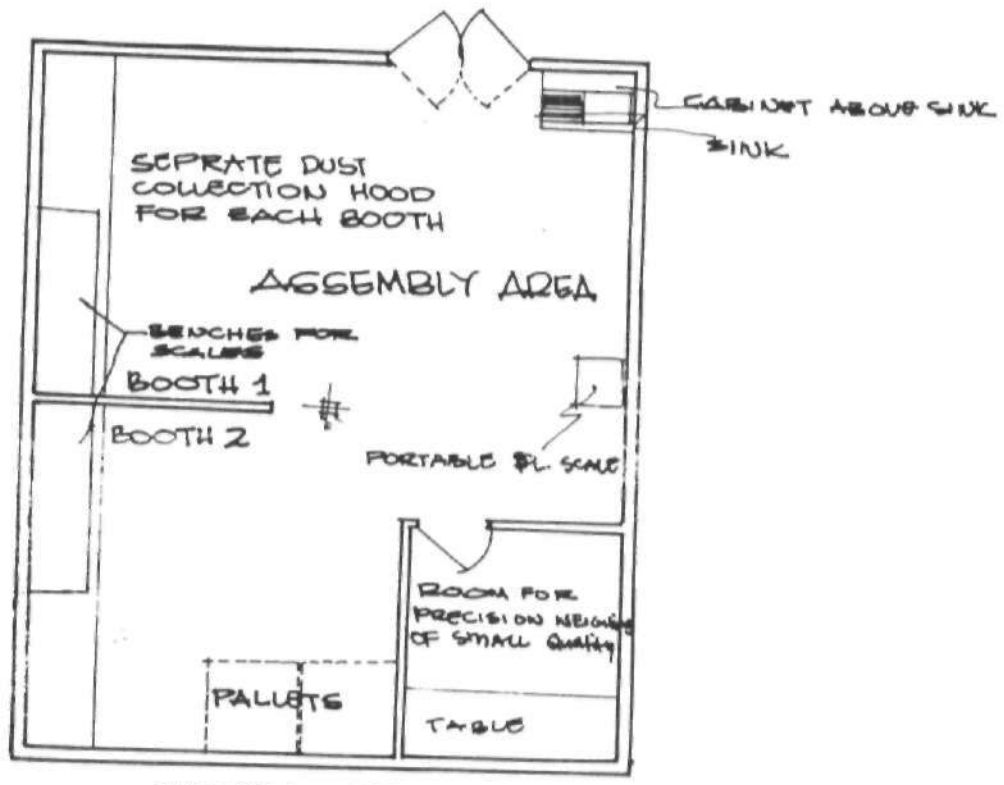
COATING ROOM
SCHEMATIC



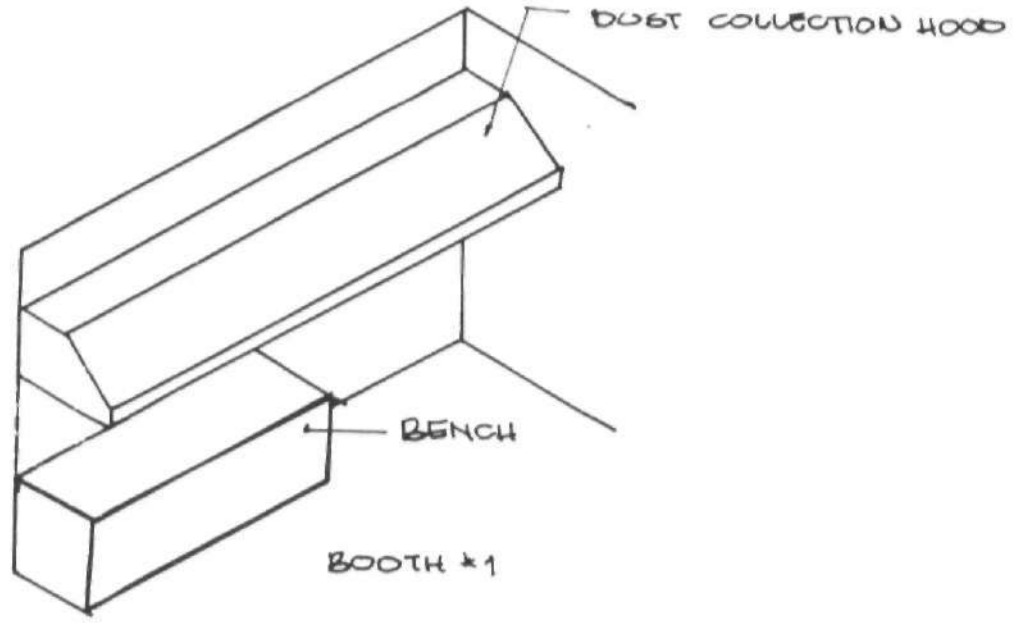
ELEVATION 'A'
SCHEMATIC

TOP:- AN ENCLOSED BANK OF COATING PANS
BOTTOM:- DIFFERENCES BETWEEN OPEN AND ENCLOSED PANS

FIG. 2.10



CHEMICAL WEIGH RM
SCHEMATIC



TOP:- TWO WEIGHING BOOTHS TOGETHER
BOTTOM:- WORK BENCH AND HOOD

Fig. 2.11

2.5. Special Needs in Pharmaceutical Research

Documentation of medicinal plants must be treated as a matter of extreme urgency since many traditional healers who are the custodian are old men and in many cases, they have no records. There is therefore the danger that this cultural heritage and basic for future research may be lost for ever.

Another consideration is that medicinal plant collected should be identified, labelled and deposited in a herbarium. In most cases plant has to be deposited first in a herbarium before research work on their constituents can be published (8).

A computer data base to be provided for drugs entering Nigeria ought especially collating information of pharmacokinetic and/or idiosyncratic reactions to drugs by Nigerians so as to help in dealing which drugs to ban or modify (10). By using computerised data base established on new and old drugs the proposed centre would be able to assist to predict for its research scientists, new drug analogues worthy of syntheses, on structure activity relationship studies.

Experimental animal for research such as mice and guinea-pigs will be required in large numbers in the research centre. This is because their metabolic pattern is similar to that of man, it should possible to test many ofthose herbal drugs on sub-human primates

in which the required diseases can be induced. A medicinal plants garden where a plantation of selected medicinal plants is needed in some cases to provide a uniform and ready source of material for research and these has to be within easy reach of the laboratory.

2.6. Organization and Operation of the Centre

All research institutes in Nigeria are presently under the Ministry of Science and Technology. Research programmes are chosen within the National Science and Technology policy approved by the Ministry, designed to achieve the goals of the National Development plan. Projects are individually analysed before they are adopted. The analysis considers the objective, the potential value, amount of research effect and estimated funds required to complete the project.

The proposed research Centre, in order to be effective, must be organized in synchrony with the existing superstructure of research operational ramifications in the country. With this objective envisaged, the following proposals are advanced:

(i) A Governing Board, made up of people drawn from industry, academic circle and government, should be appointed by the Ministry and among them a Chairman should be elected to oversee the implementation of the general policy drawn up by the Board.

(ii) Next, a Director whose duty would be the day-to-day administration and execution of research programmes whould be appointed among members of the Board. Preferably he should be a man of proven research ability. For only then can he give the needed leadership in directing the Centre towards its goal.

(iii) Under the Director is the Deputy Director who will assist the Director in the running of the research centre. There will then be various Head of departments who will head various section of the Technical Division. The number of departments grow just as new requirements come to light from time to time. At this initial stage the operational departments considered include: the general administration, information, research, welfare, services and maintenance departments.

The operations and activities in all the departments are closely related. The interrelationship is more crucial in the research departments as essentially, all the scientific research staff are "fluid". The method of research being advocated and encouraged is the Multi-Disciplinary approach". This method of research in the work of experts of different disciplines working separately on various aspects of primary objective. The synthesis of results of the research work is done by the research manager. This allows for vertical developments of results and mission oriented.

Flexibility in personnel assignments is therefore necessary and provision must be made to facilitate it. The technicians, especially of the junior and intermediate ranks and clerical staff attached to the research departments shall, however, remain essentially non-fluid.

2.7 Architectural Implications of Organisational Structure

Because of the impredictable nature of research work, flexibility is essential in all aspects of the design ranging from site planning (in which adequate provision must be made for future expansion) to the accommodation to be provided for offices and laboratories.

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Chapter 3

LABORATORY PLANNING

3.0 Introduction

The focal area of any scientific research establishment is the laboratory. The basic concept of a laboratory is the provision of a suitable environment for the performance of a specific discipline. This concept being applicable whether the laboratory is but a single room under the control of one person or a complex of differing units housing several hundreds scientisits.

Laboratories can broadly be classified as:

a. Teaching laboratories for scientific and medical purposes.

b. Research laboratories for the study and development of new possibilities, working to a flexible programme.

When the function that the laboratory is to fulfill has been clearly established and the use and nature of the work are fully understood, an assessment must be made of the factors influencing design and the achievement of a final solution.

3.1 Types of Research Laboratory

There are two main types of research laboratory

- bench scale
- fixed plant

In bench scale laboratories, the floor area per work place is defined by the required length and width per individual worker. The length is the total length of benching, sink, and so on, which the scientist needs. The width is established by the width of his benching plus the clear floor area needed for movement while working. Additional 'balance' areas is accounted for by ducts and rooms associated with the general laboratory space. The bench type laboratory could be referred to as the "general research laboratory".

The fixed plant laboratory has its spatial requirements dictated by the size of the machinery. In this light, area requirements is subject to type of equipments that will be used.

3.2.0. General Laboratory Space

General laboratory space may be regarded as the scientists' working base, and for the purpose of planning it forms the centre of laboratory activities. With the excention of men engaged exclusively in administration, every scientists needs this kind of space, which must be supplied with services and may or may not be equipped with conventional laboratory benches.

The floor area needed in the laboratory for an individual worker is defined by two dimensions: length and width.

Length - is the total length of benching, sink, fume cupboards, etc., which the scientists needs for the work.

Width - is established by the width of his benching, plus the clear floor space needed for movement whilst working and for circulation between the benches - these dimension define a rectangle.

Space requirements for an individual in a room housing several workers are substantially less than would be needed in a one-man room because in such rooms circulation space and to some lesser extent, the working space are shared. It is therefore economical to design research laboratory rooms for two or three workers (1).

3.2.1. Bench Length

Straight run of benching is much more convenient and desirable for users than bench runs that go-round the corner. It should be the objective of the designer of any research laboratory to provide for uninterrupted runs of benching of at least 4.5m in length. This length should excludes the liner space for fume cupboards, sinks, reading and writing activities (2).

3.2.2. Bench Width

Arm reach from standing or sitting positions controls the width of bench on which manual operations can be carried out without leaning the body forward over the bench. In laboratory where safety is of major importance, the criterium should be to provide a bench width which allows the scientists to work in comfort but which does not encourage him to lean so far that quick recovery or retreat become impossible. From a survey carried out by the NUFFIELD Foundation (3) it was found that "if an allowance is made for leaning, a bench width of 600m would allow comparatively easy manipulation of service tape and outlets". The nearer these services points are to shoulder height, the easier they will be to operate.

3.2.3. Space Between Benches

In considering space to be left between parallel runs of laboratory benching, the following factors are relevant:

(i) space taken up by worker when actually engaged in working at the bench.

(ii) space taken when walking parallel with and close to the bench and for emergency movement.

(iii) space needed for bending down in front of bench, for example, to take something from cupboards under the bench.

(iv) space needed for use of trolleys carrying supplies or equipment such as portable pumps and lampressor.

(v) space needed for two persons working back to back and at least one person passing between them.

With due consideration for each of the above factors, it would be agreed that a two-metre spacing between the benches is optimum.

3.2.4. Additional Space Requirements for Laboratory Bench

The additional space requirements are those for sinks, draining boards and fume cupboards. Two kinds of sinks are provided in laboratories: large sinks, with draining boards. For washing up and drainaways or cupsinks. For receiving effluents from experiments, provision of drainaways is an integral part of servicing arrangements for the working bench sinks. For washing up and their draining-boards are additional to normal benching.

An overall length of about 1.5m is considered likely to meet most demand (4). It must be noted that in many research establishments, washing is done centrally.

Fume-cupboards should be provided in every laboratory space, even if they are rarely used, in the interest of flexibility and health of workers. They should not be located where it will block an exit. They are of standard sizes, so that appropriate length may be chosen depending on anticipated use.

3.2.5. Type of Bench

There are three types of bench - peninsular, island and wall. As the names imply, the peninsular bench projects from the wall and the island bench is free-standing.

Peninsular benches are preferable to island benches because the installation of services is easier and less costly.

Wall benches under windows should be avoided; facing the sun in front of windows on the east and west elevations makes working condition quite intolerable.

Whether it be a one-, two- or three-module laboratory, the combination of peninsular and wall bench at right angles to external wall produces the simplest layout. The one module-laboratory provides the most wall space per unit area; the three module laboratory has the widest application because in many cases, it accommodates the optimum number to share equipment and facilities.

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3.2.6. A Unit Laboratory Space

The limiting dimensions of a basic laboratory room will depend on:

Length - which is determined by the necessary serviced wall or bench.

Width - which is determined by the optimum width of bench and the amount of clear space between runs of equipment or benching.

Based on the research findings and recommendations of **NUFFIELD** Foundation, a unit laboratory gives an overall depth of room, from corridor to the outside wall of 24 feet to 25 feet (6.3m - 6.6m) shallower rooms will not provide the essential 15 feet (4.5m) run of available bench space. The same NUFFIELD Foundation recommended that the centre to centre dimensions between runs of benching may be between 10'.6" (3.2m) and 2'-0" (3.6m) (5).

The unit laboratory space gives the module for the design of the whole laboratory complex.

3.3.0. Rooms Associated With Laboratory Space

In general term spaces associated with research laboratories could be classified into two categories as used by the NUFFIELD Foundation (6).

Primary space - which includes the general laboratory and special services rooms closely associated with the general laboratory.

Secondary space - which includes scientists offices, stores, rooms, boiler rooms, stair-lifts and corridors, conference rooms, etc.

3.3.1. Offices for Scientific Staff

A good deal of scientist's time is spent in reading and writing. The best location for offices in the laboratory is always a controversial subject. Are they to be within the laboratory, adjoining the laboratory, on the opposite side of the corridor or grouped in a separate part of the building?

According to a survey carried out by the Division for Architectural Studies of the Nuffield Foundation most scientists consider a small office within the laboratory entirely satisfactory (7). The argument is that scientist spend most of their time actually working in the laboratory and the closeness to work in progress out-weighs the advantages of greater privacy and silence in larger office across the corridor. Against this, it has been pointed out by Haines (1950) that floor space in the laboratory area is very expensive. A compromise solution to this conflict may be found by planning very small offices, no larger than cubicles, directly adjoining the laboratory.

Apart from the provision of office space for working scientist, there will, of course, be a need for office accommodation for more senior scientist whose time is spent mainly or wholly on administration.

3.3.2. Rooms for Special Purposes

Apart from offices certain special rooms are found in close association with laboratory spaces. These include balance and instruments room, dark rooms, controlled environment rooms, rooms for housing special techniques e.g. chromatography.

A very good method of providing these rooms is to ensure that the general laboratory space lends itself to sub-division, in such a way to enable rooms of appropriate sizes to be formed by removable partitions which can be removed for space to revert to general laboratory use.

For economy purpose, it is better if they are provided where they can be shared by a large group of workers.

For the purpose of pharmaceutical research, some of these special rooms that are needed include:

a. Balance and instrument room
b. Rooms with controlled environment
c. Sterilization
d. Animal houses.

Each of these rooms has some special design features.

(a) Balance and instrument rooms: Balances are used often in a pharmaceutical laboratory for weighing. Sensitive balances, used for weighing micro-quantities require protection against vibration. Balances are not normally placed near heat sources and must be protected against solar heat gain. Balance room should almost be free from contamination by corrosive fumes, excessive humidity, dust, etc. It is better that they be provided where it can be shared (8).

(b) Rooms with controlled environment: The range of provision of controlled environment in pharmaceutical laboratories varies greatly at one end of the scale small refrigerators, incubators, or ovens are placed in the laboratory, at the other, controlled temperature rooms are equipped for storage of large numbers of samples (e.g. storage of media in quantities), or to accommodate experimental work.

Often temperature only is controlled, but there are cases in which humidity is also of importance.

Good thermal insulation is essential to controlled environment rooms, and is made easier and thus cheaper by removing the rooms from the effects of fluctuations in outside temperature. Natural light is not usually needed and rooms can be planned away from external wall.

(c) Sterilization: In microbiological, pharmacological and biochemical departments, glassware, apparatus, and media must be sterilized. Sterilization processes involve removing dangerous organism from these materials. Autoclaves are normally employed for sterilization process.

Good ventilation is extremely important in sterilizing room and is always good to take precuation against condensation.

(d) Preparation of media: In microbiology, much of the experimental work involves growing cultures, and artificial media are often prepared on which to grow them. Media preparation is a cooking process and the requirements include serviced bench (water, gas, and electricity), scales and a balance, filters, and general cooking utensils. A supply of distilled water is necessary and adequate local storage for ingredients, chemicals, and glasswares are also necessary.

Incubators are used for drying the media and autoclaves for sterilizing.

(e) Animal houses: Experimental animals for research are needed, such animal include mice, rats, guinea-pigs, and rabbits. Animal houses are designed either for breeding and maintaining a supply of animals, or to house animals on which experiments are being conducted.

It is generally accepted that large animal houses, especially one meant for breeding should be in a separate block or wing, easily accessible to the laboratory workers concerned, but for small animals units, it could be part of the general laboratory.

The design of animal houses is influenced by certain environmental conditions. Animals are affected by noise, changes in temperature, draughts and to some extent lighting. The heating and ventilation of animal houses is of great importance to the animal's well-being.

Humidity control and natural lighting is not essential in animal rooms. If there are windows, they may be small and from point of view of maintaining an even temperature, the smaller they are the better.

3.4.0. Laboratory Services

The servicing of laboratory building is complex and expensive. Heating, ventilating and air-conditioning systems and the multiple pipes of various services such as water, gas, vacuum, and oxygen create a demand for cubic space as well as floor space. Associated with this need for additional space for services is the need to provide functional space for the unseen occupants of the building: maintenance and operating engineers, and the craftmen who provide for the continual changes and adjustments in the services systems which mark an active research programme.

3.4.1. Selection of Services Distribution System

Selection of services distribution systems strongly influences the configuration, design and cost of research laboratory building. Room arrangement and equipment location should follow the service distribution pattern. The service distribution pattern chosen, should be identified on each floor and designed to flexibly meet the capacity needs of the programme that will occupy the building over its life with appropriate consideration of costs (10).

3.4.2. Types of Services Distribution System

Services are usually provided within a research laboratory building by either horizontal or vertical distribution system or a combination of the two. Vertical sub-mains are fed from borizontal mains carried at low level (e.g. in the basement) or high level (e.g. above the top floor). Horizontal sub-mains are taken from vertical mains which are usually carried in structural ducts running vertically through the building at one or more points.

In services distribution systems using vertical sub-mains, shafts containing ducts are carried at each or alternate module, either on the corridor wall on the outside wall. Particular benches attached to either corridor walls or outside walls respectively constitute the most economical bench layout in

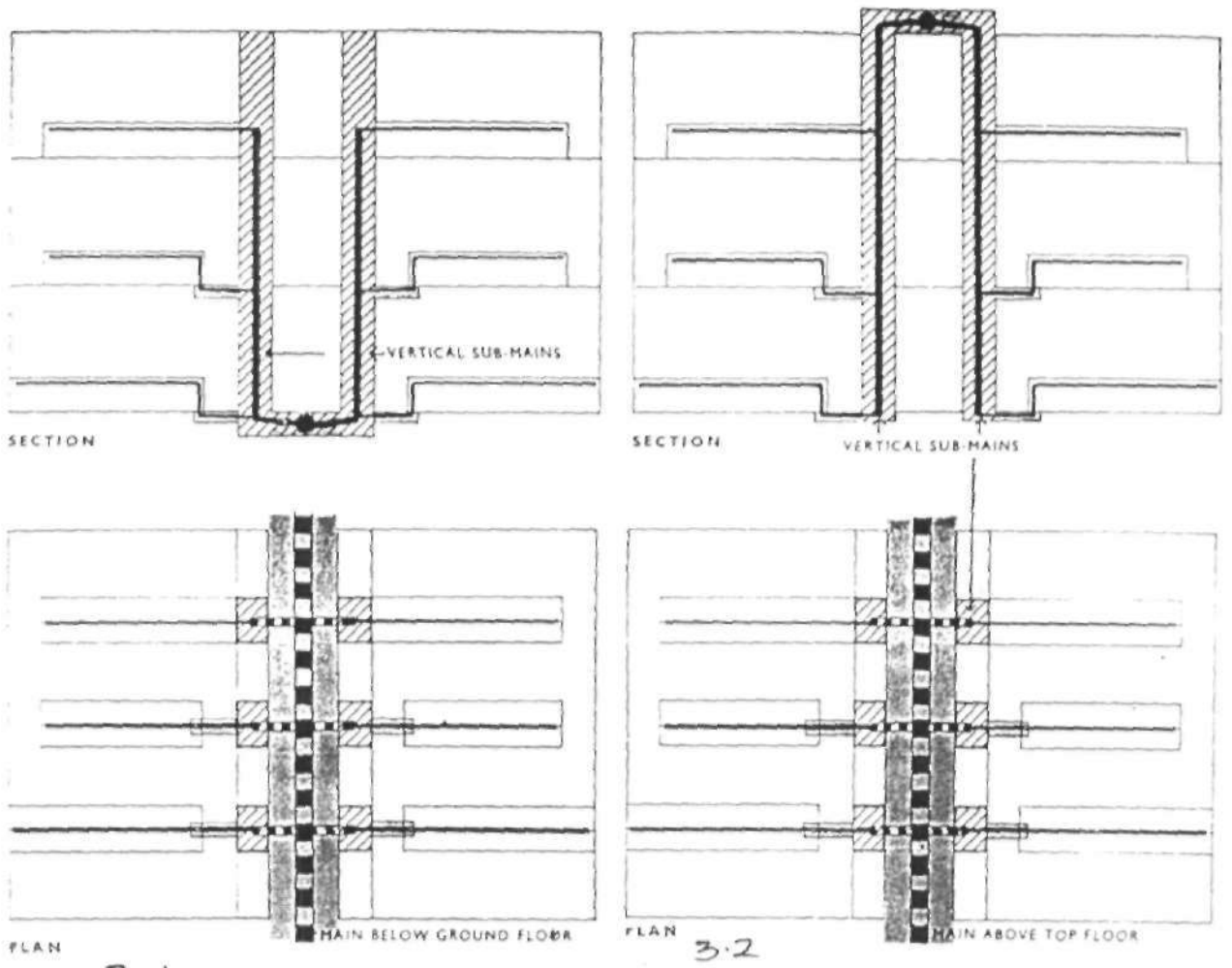
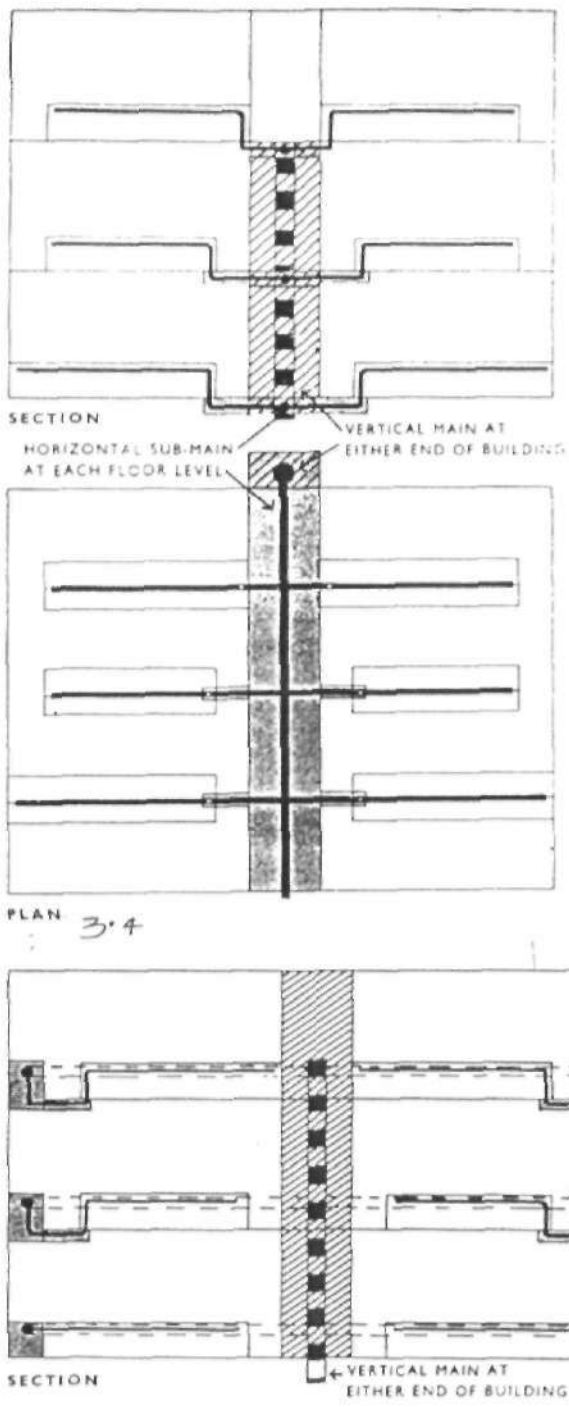
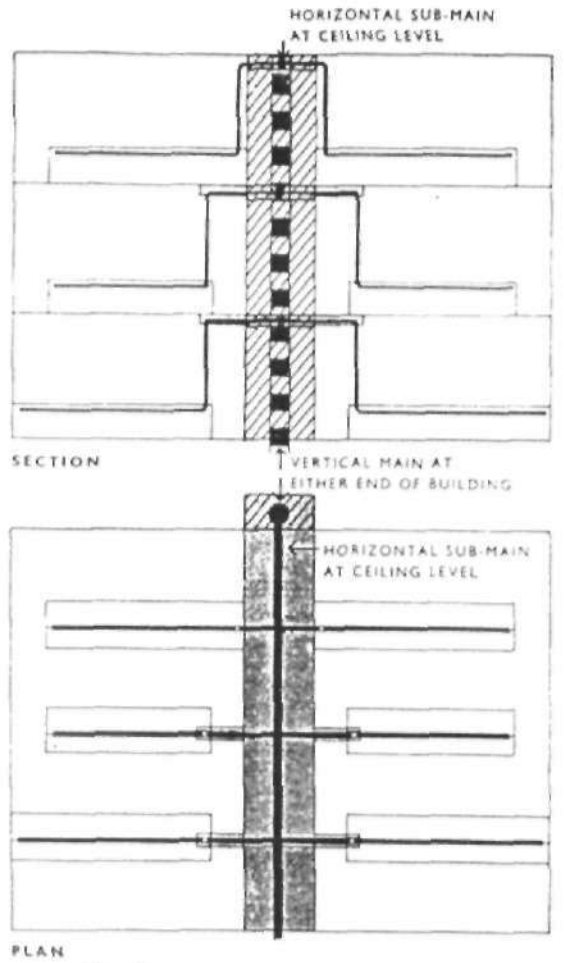


Fig. 3·1 Vertical sub-mains from a horizontal main below ground floor level.

Fig. 3·2 Vertical sub-mains from a horizontal main at high level.

Fig. 3·3 Vertical sub-mains on the outside wall taken from a horizontal main at low level.





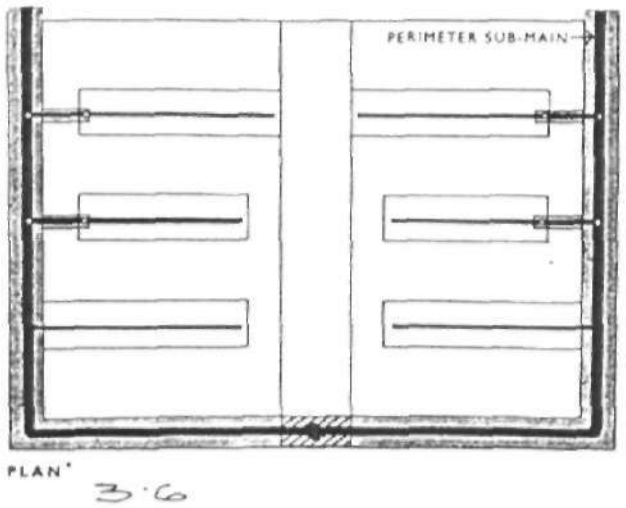




Fig.3·4 Horizontal sub-mains in floor ducts at each floor level from a vertical main at one end of the building.

Fig.3·5 Horizontal sub-mains in the corridor between the structural floor and a false ceiling. Vertical main at one end of the building.

Fig.3·6 Horizontal sub-mains around the perimeter, below window level. Vertical main at one end of the building.

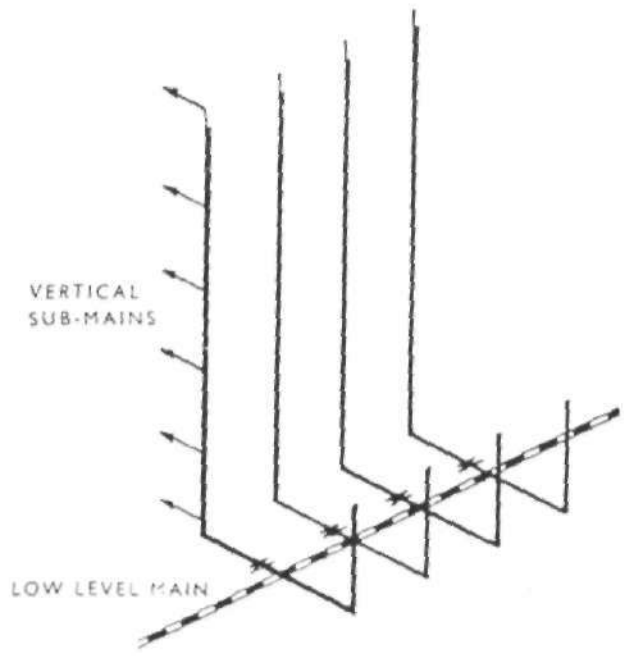


Fig.3·7 Vertical sub-mains fed from a main at low level using one vertical riser for each cell.

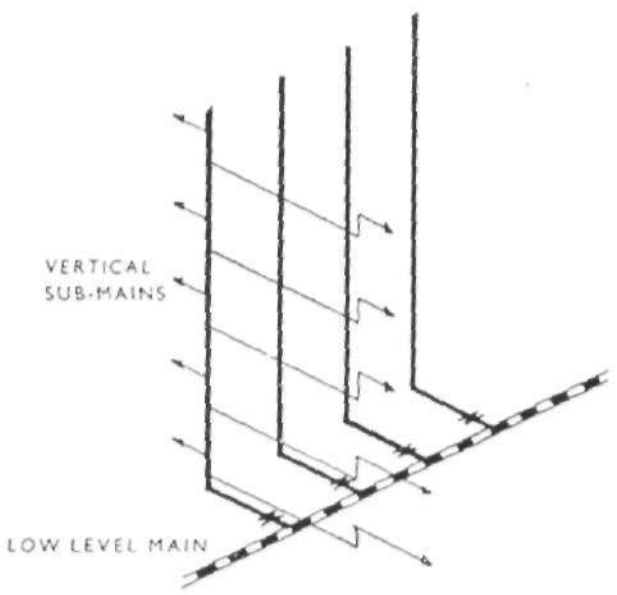


Fig.3·8 Vertical sub-mains fed from a main at low level using one vertical riser for each pair of cells, one on either side of the corridor.

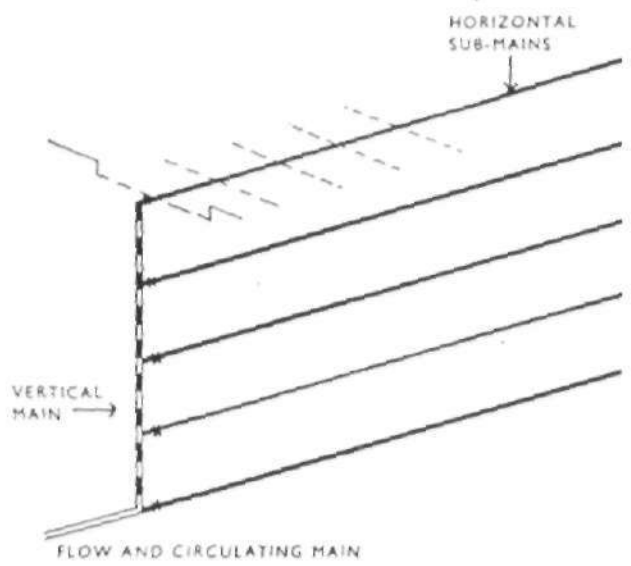


Fig.3·9 Horizontal sub-mains at each floor level fed from one vertical main.

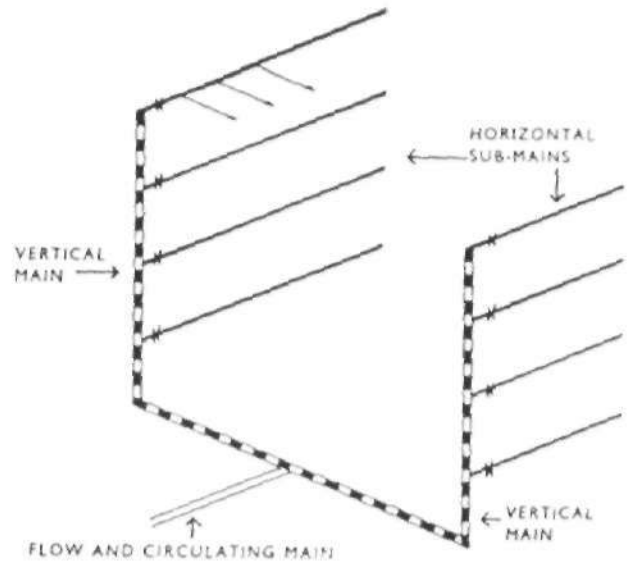


Fig.3·10 Perimeter sub-mains at bench level fed from two vertical mains.

conjunction with this type of servicing, as the pipe lines supplying the bench points can be taken directly from the sub-main without further structural duct work.

In the horizontal sub-mains system, the horizontal sub-mains supply a number of adjacent rooms at each floor level. Pipes and cables run at high floor or low level in floor ducts or between the structural floor and false ceiling, horizontal sub-mains may also run around the perimeter of the building below window level.

There are five systems making use of vertical or horizontal or both sub-mains distribution generally employ to distribute laboratory services.

1. The service corridor system
2. The multiple interior shaft system
3. The multiple exterior shaft system
4. The corridor ceiling with isolated vertical shafts
5. The services floor system.

Service Corridor System: In the service corridor design, all service mains and ducts are brought to the various floor levels by means of a vertical central core which distributes the services by vertical mains, usually from a basement, but sometimes from a roof mechanical room. The horizontal distribution system from the central core may be at ceiling and downwards to individual casework or it can be directly along the

floor through the wall in the pipe space behind the base cabinets.

Application: Most applicable to multi-storey buildings with square rather than rectangular shape. It can only be used with reservations for laboratories with one or two floors.

Advantages:

(i) Excellent flexibility
(ii) Moderate initial cost
(iii) Low modification cost
(iv) Low replacement cost
(v) Low maintenance cost
(vi) Permits full utilization of walls
(vii) Modification do not interfere with conduct of work in adjacent modules.

Disadvantages:

(i) Fair net to gross area efficiency which improves when units are located in parallel thus saving on corridor.
(ii) All rooms are inside rooms.

Multiple interior shaft system: This systems provides for concealed services with duct work and plumbing services in a series of regularly spaced located either on both sides or on one side of a

circulation corridor. All service mains and ducts are brought vertically to the various floor levels either upward or downward from the mechanical room. The shafts are located in each or alternate laboratory module or room on both sides of the central corridor. Distribution of services from the vertical shafts into the laboratory working areas is generally in pipe spaced behind the laboratory benchwork.

With the exception of plumbing drains, in some designs the services are extended from the service shaft below the ceiling in the laboratory and then downwards to the laboratory benches. The interior services system is not a good selection for buildings with only one or two stories, it is most efficient in multi-storey buildings and is frequently found in those with a long rectangular shape.

Advantages:

(i) Good flexibility

(ii) Moderate net to gross area efficiency

(iii) Moderate initial cost

(iv) Moderate modification cost

(v) Easier to service than the exterior shaft system.

Disadvantages:

(i) More expensive and not as flexible as exposed system.

(ii) Available space usually does not permit individual supply and exhaust fume hood.

(iii) Servicing interferes with traffic floor in corridors.

Multiple Exterior Shaft System: This system brings service mains and ventilation duct work to individual floor levels by a series of vertical exterior wall shafts located at each or alternate laboratory rooms or modules. Utility services are distributed from these exterior shafts into the laboratory rooms by means of the pipe space behind the base cabinets of the fixed equipment, or at the ceiling level. Because of its high cost, the multiple exterior service shaft system should generally be considered only for multi-storey laboratories.

Advantages:

(i) Good flexibility
(ii) Moderate net to gross area efficiency
(iii) Moderate initial cost
(iv) Moderate modification cost
(v) Moderate replacement cost
(vi) Low cleaning (maintenance) cost
(vii) Permits full usage of walls
(viii) Utilities are common with direct work and drainage system.
(ix) Good appearance.

Disadvantages:

(i) More difficult to service or modify than other recommended system.

(ii) Requiries removal of one section of casework.

(iii) Modification interfere with conduct of work in adjacent modules.

(iv) More expensive and not as flexible as exposed systems.

(v) Available space usually does not permit individual supply and exhaust fume hoods.

Corridor Ceiling Distribution System: In this system, services are located in the corridor ceiling and in some cases above the ceilings of the rooms on each of the corridor and are supplied by one or two vertical pipe shafts. Distribution from the ceiling mains to the laboratory areas may be downward to the floor or upward through the floor above in order to supply two floors from one ceiling distribution arrangement. Generally, it is preferable to provide the distribution downward within each room to avoid perforation of the floor slab and consequent leaks and flooding due to accidents in later years.

This system is commonly used in research buildings with only one or two stories or where a single research floor is inserted in a multi-storey building primarily designed for other purposes.

Designs employing exposed services are ideal for two-storey or one-storey-and-basement buildings where economy of construction is a major consideration.

Advantages:

(i) Excellent flexibility
(ii) Low initial cost
(iii) Low modification cost
(iv) Low replacement cost
(v) High net to gross area efficiency
(vi) Modification do not interfere with conduct of work in adjacent modules.

Disadvantages:

(i) Requires increased ceiling height for same clearance.
(ii) Limits installation of wall cabinets
(iii) Increased cleaning (maintenance) costs
(iv) Requires independent type of air duct installation and drainage system
(v) Unsightly

Service Floor Distribution System: This system probably provides the maximum flexibility and capability in research laboratory structures. Services, consisting of duct work and the plumbing systems, are in separate floor from the supply, the service mains and trunk ventilation ducts are brought to each individual centrally located vertical shaft or tower,

then the distribution is made laterally on each utility floor with final distribution made by penetrating the floor below or above to service the research laboratory areas.

Although this system has unlimited flexibility, its cost is high and it has an extremely low net gross area efficiency. This system is primarily suitable only for multi-storey buildings.

Advantages:

(i) Excellent flexibility to any portion of the room.
(ii) Low modification cost
(iii) Low replacement cost
(iv) Modification do not interfere with conduct of work in adjacent modules.
(v) May be used with up-feed at every floor or it may be combined with down-feed and located at every third floor.

Disadvantages:

(i) Very high first cost
(ii) Low net to gross area efficiency.

In general, complete and easy access to the services is very essential while provision must be made for easy and rapid addition and adaptation to the services.

The factors which affects the efficiency and cost include:

(i) The number and types of services.

(ii) The routing of services through buildings from the point of entry of the mains to the bench outlets.

(iii) The number of outlets required at bench position.

All these have a direct bearing on the degree of flexibility, the ease and convenience of maintenance as well as cost of installations.

Services outlets and lines should be made easily indentifiable and distinguishable. This is usually done by colour coding, shape of handwheel and labelling system.

3.5.0. Layout of Laboratory Buildings

The layout of laboratory building is often determined by the type of corridor adopted. Though the planning of each laboratory building has its individual problems, range of layouts can be narrowed to a few corridor arrangement which have been found satisfactory (9).

There are five types of corridor

- single loaded corridor
- off-centre corridor
- central corridor
- double corridor
- service corridor

3.5.1. Single Loaded Corridor

This type of layout is often employed in the areas where natural ventilation and lighting are often of utmost important. It has the advantage that laboratories can be made to face any particular direction of interest. It provides flexibility in planning but it decreases the assignable gross area and therefore increases cost.

3.5.2. Off-Centre Corridor

This type of layout has a wide application for small schemes. It has the advantage that all laboratories can have a south or north facing aspect and the two rooms provide flexibility in planning.

3.5.3. Central Corridor

This type of layout is more suitable for large schemes. It has the advantage that the grouping of laboratories is more compact because they are on both side of the corridor. It also provides greater assignable

space as the corridor is used on both sides. It has the disadvantage that there is no cross-ventilations and some time absent of natural lighting along the corridor.

3.5.4. Double Corridor

This is probably the best arrangement that provides good interrelationship between laboratory, laboratory office and service laboratory. It sometimes offers best solution when the width of the building is fixed within certain limits. Accurate temperature control can be obtained in the service laboratory, since there is no window. There is however a decrease in the ratio of assignable to gross area and therefore it increases the cost. Lack of cross ventilation is also inherent in this arrangement.

3.5.5. Service Corridor

This is especially suitable for larger schemes, where services are more complex and temperature control a critical factor. The increase area at one level contributes to more efficient operation since staff are brought closer together and sharing of equipment is facilitated. There is however no cross-ventilation.

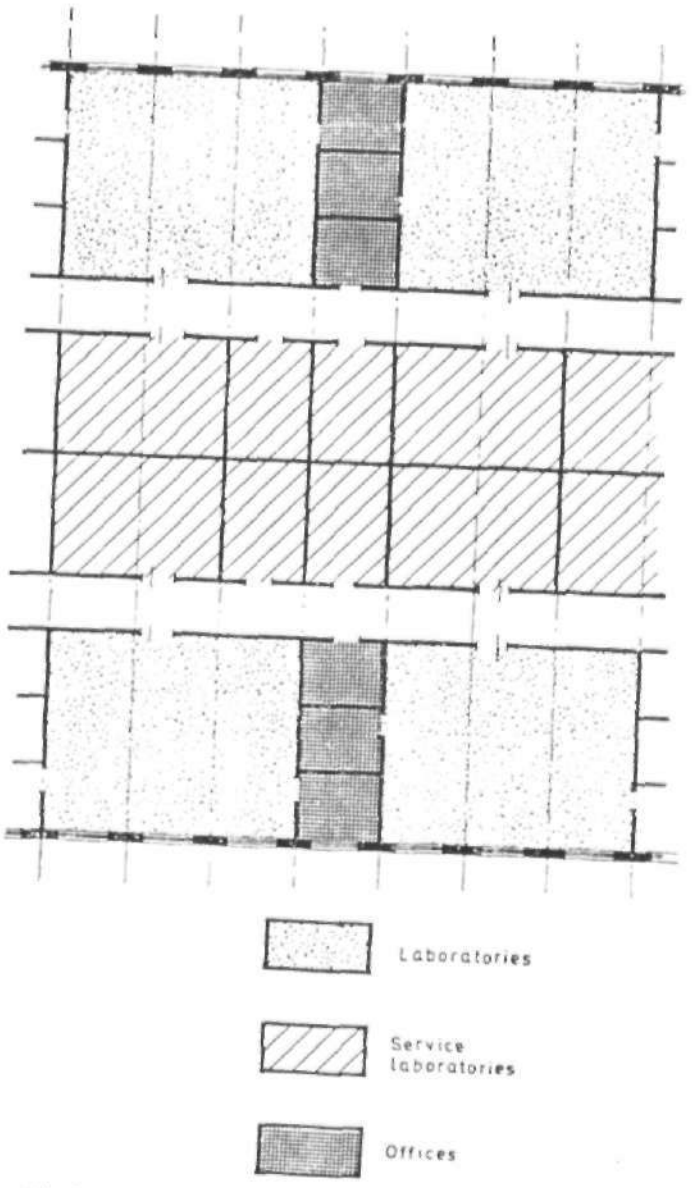


FIGURE 3·11 *Double corridor layout, showing relative positions of laboratories, service laboratories and offices.*

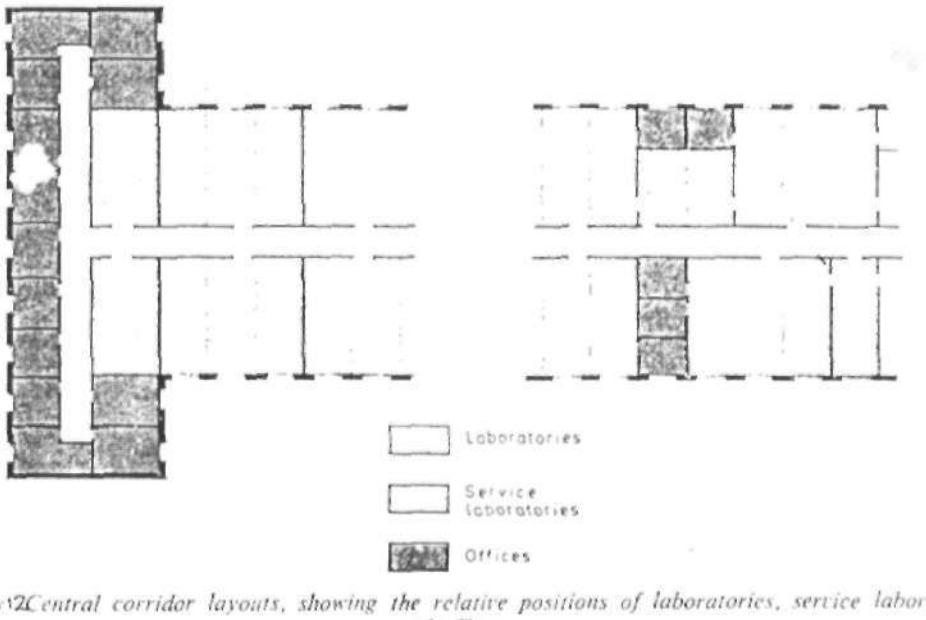


FIGURE 3·12 *Central corridor layouts, showing the relative positions of laboratories, service laboratories and offices.*

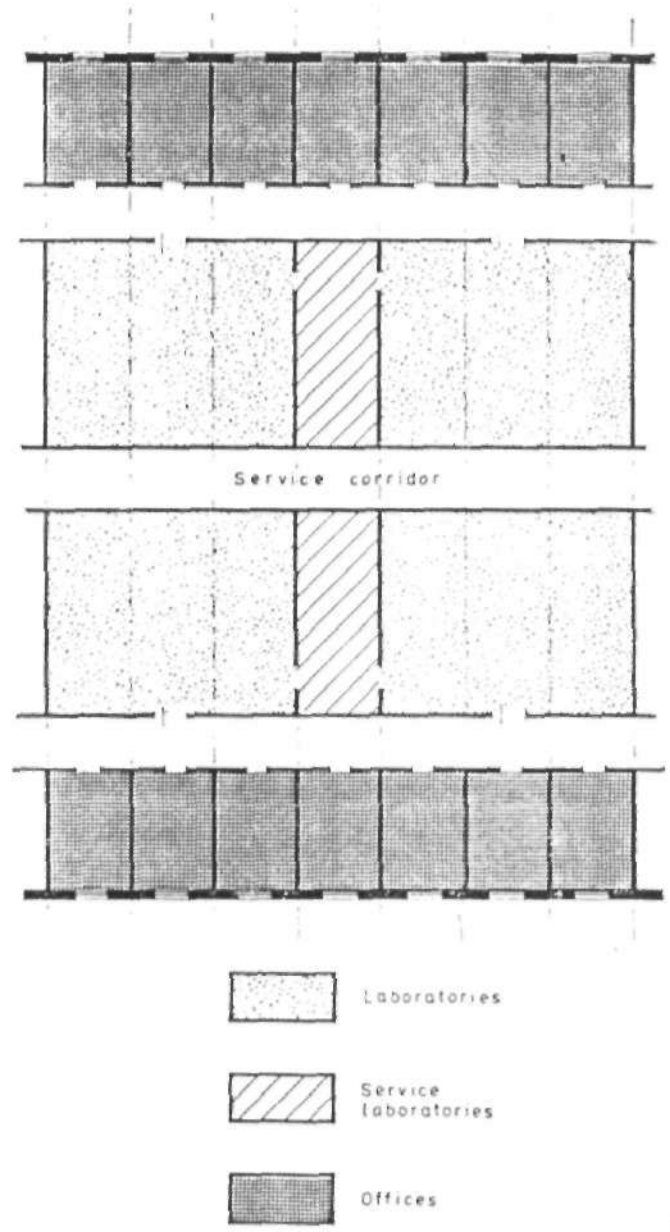


FIGURE 3·13 *Double-width layout with service corridor, showing relative positions of laboratories, service laboratories and offices.*

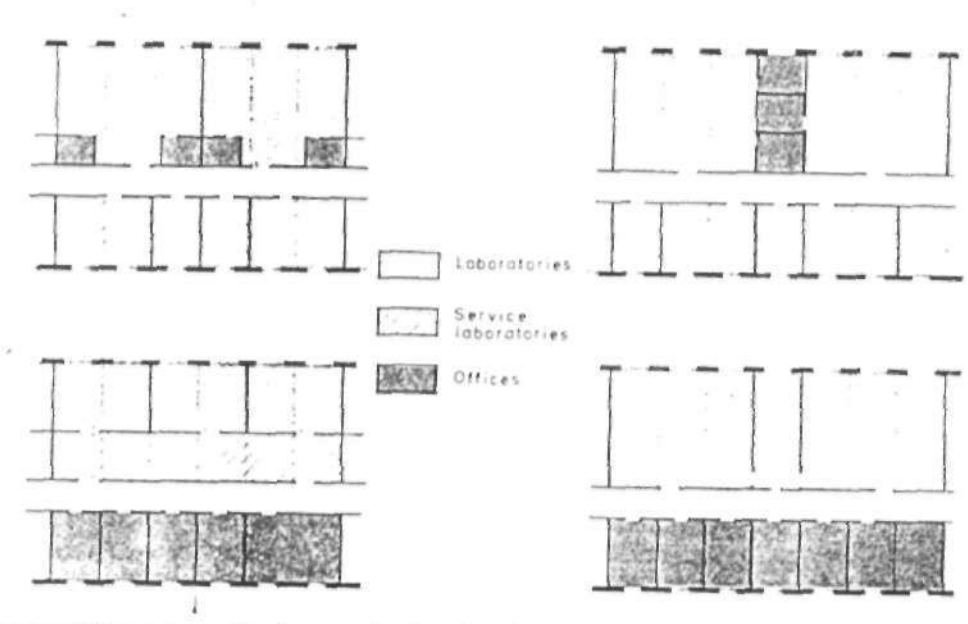


FIGURE 3·14 *Off-centre corridor layouts, showing the relative positions of laboratories, service laboratories and offices.*

3.6. Building Shape

Different forms such as hexagons, circular and tall slim towers may be used in laboratory design. These forms are good for esthetic purposes but are less efficient than rectangular shapes. Buildings with simple shape or configurations commensurate with standard laboratory equipment and furniture, and with unrestricted accessibility to mechanical utility systems are the easiest to adapt to the changing needs of research.

3.7.0. Laboratory Fittings

A catalogue of laboratory fittings include benches, fume-cupboards, reagent shelves, balance and instrument benches, and so on.

Laboratory fittings should be of standard designs, since this will aid the scientist to indicate his requirement more quickly and the architect has fewer drawings and specification to prepare. Other advantages include saving in cost of manufacture and installation and the re-use of units even if laboratory layout is altered.

There are some fittings being manufactured and choice could be made to suit requirements. Fittings for specific and special purposes have to designed and purpose-made.

As a result of unpredictability in scientific needs, some research laboratory fittings are self-constructed and necessitated by a particular experiment.

3.7.1. Fume Cupboards

The risk of accident is greater in a fume cupboards or fume hood than else where in the laboratory. So for the reason of safety one should not be located where it will block an exit. If there is an alternative exit from the laboratory, this difficulty does not arise.

Fume hood requires an exhause duct with a diameter of 20-40cm.

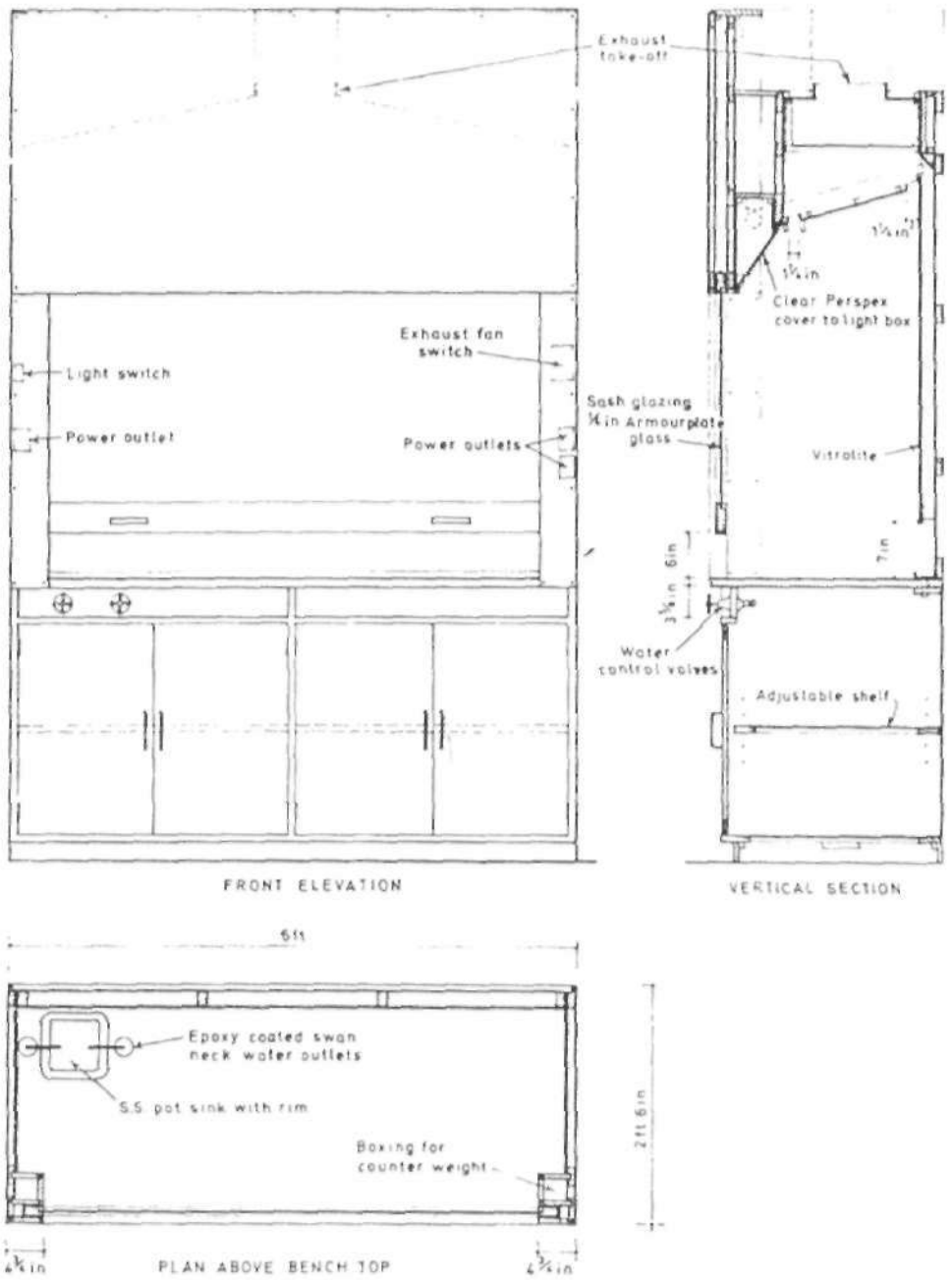


FIGURE 345 *CSIRO standard fume cupboard with sash.*

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1. Nuffield Foundation, The Design of Research Laboratories, London, Oxford University Press, 1961, p. 38.
2. Op. cit pp. 41-42.
3. Op. cit pp. 45-46.
4. Op. cit p. 42.
5. Op. cit pp. 48-50.
6. Op. cit pp. 155-159
7. Op. cit p. 57.
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9. Ferguson, W. R. Practical Laboratory Planning, London, Applied Science Publishers Ltd., 1973, p.10.
10. Chiara, J. & Co. Time Saver Standards Building Types p. 866.

Chapter 4

CASE STUDIES

4.1 Burroughs - Wellcome Company Research Centre, North Carolina's Research, Triangle Park, USA.

4.2 Faculty of Pharmaceutical Sciences, Ahmadu Bello University, Zaria, Nigeria.

4.3 Parke, Davies & Company Research Centre, Ann Arbor, Michigan, Britain.

4.4 Hoechst Research Centre, Frankfurt (M) - Hoechst, West Germany.

In order to boost the author's knowledge in this study, the author have decided to study some of the existing related facilities around the world especially from the United States, Britain, West Germany and here in Nigeria.

Unfortunately, there has not been any research centre of this kind in Nigeria, except the school of Pharmacy which only perform basic research expected in a University setting, but with the ones available, it would be beneficial for this study.

There are many methods of evaluating buildings. Some are very formal requiring a team composed of a variety of professionals, numerous interviews, questionnaires and observations and they take as

many as five years to produce a voluminous report.

Others are very casual requiring a minimum criteria and this involve maximum subjectivity.

In this study, the method adopted is one which evaluate a building from the selection of site to the effectiveness of the functions it is designed to perform. More emphasis is placed on the relationship to the theme of this study.

4.1 Burroughs - Wellcome Company Research Centre, North Carolina's Research Park, USA
Architect: Paul Rudolph

Burroughs-Wellcome is a world-wide Pharmaceutical Company with Headquarters in North Carolina. The company has a branch in Nigeria (Wellcome Nig. Ltd.).

Site Selection and Brief

The site is about 66 areas of rolling-woodland approximately equidistant between Raleigh, Durhan and Chapel Hill. The site is closely linked with three surrounding Universities. The building was to serve as the main laboratory and corporate headquarters of the company. As part of the brief, the client had wanted a building that was shaped to his needs with some architectural distinction.

Description of Functions

The complex consists of a five floors to which are distributed the laboratory and administrative spaces. Reception, Cafeteria, Library, Auditorium and administrative office flanked the entry courts, while laboratories, research offices and animal quarters surrounds the service yard.

Planning

The whole complex consists of 28,000 square metres of laboratory and administrative spaces. The primary goal of the design was flexibility. Each major area in the complex - laboratories, administration and support services - can be expanded by simple linear addition. The expansible ends of the building was expressed in random pattern of flattened hexagons. Any of the elements can be extended horizontally without disturbing the buildings visual order. This device, combined with an elaborate articulation of parts complicates the elevations considerably but gives the building an agreeable scale and plunges it squarely into the realm of dynamic architectural sculpture.

Structure

The structure is eccentrically loaded trapezoidal steel frame with columns inclined at $22^{1}/2$ degrees.

To absorb the substantial bending moments, floor beams and columns are linked in transverse direction by a rigid moments connectors. The beams below grades, take up the horizontal components of all gravity loads.

Service Distribution System

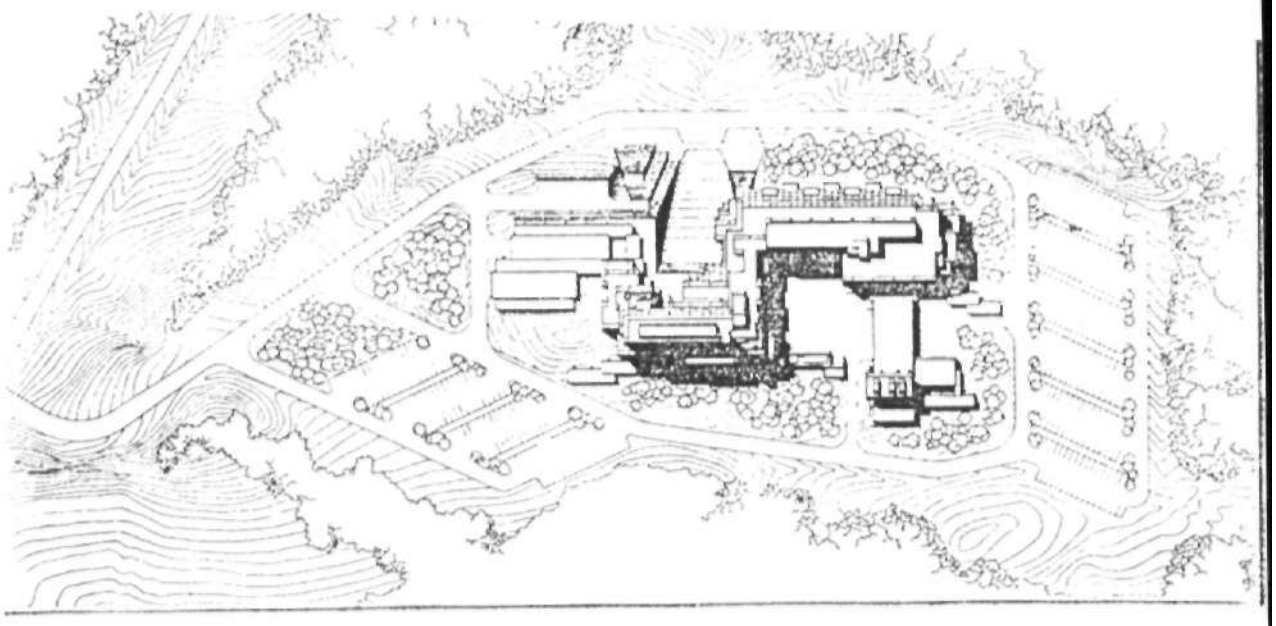
Diagonal line of force make themselves felt throughout the building. Sloping shafts lined the corridors and these are used for housing the heavy mechanical services requirement in the laboratories and research spaces.

Advantages

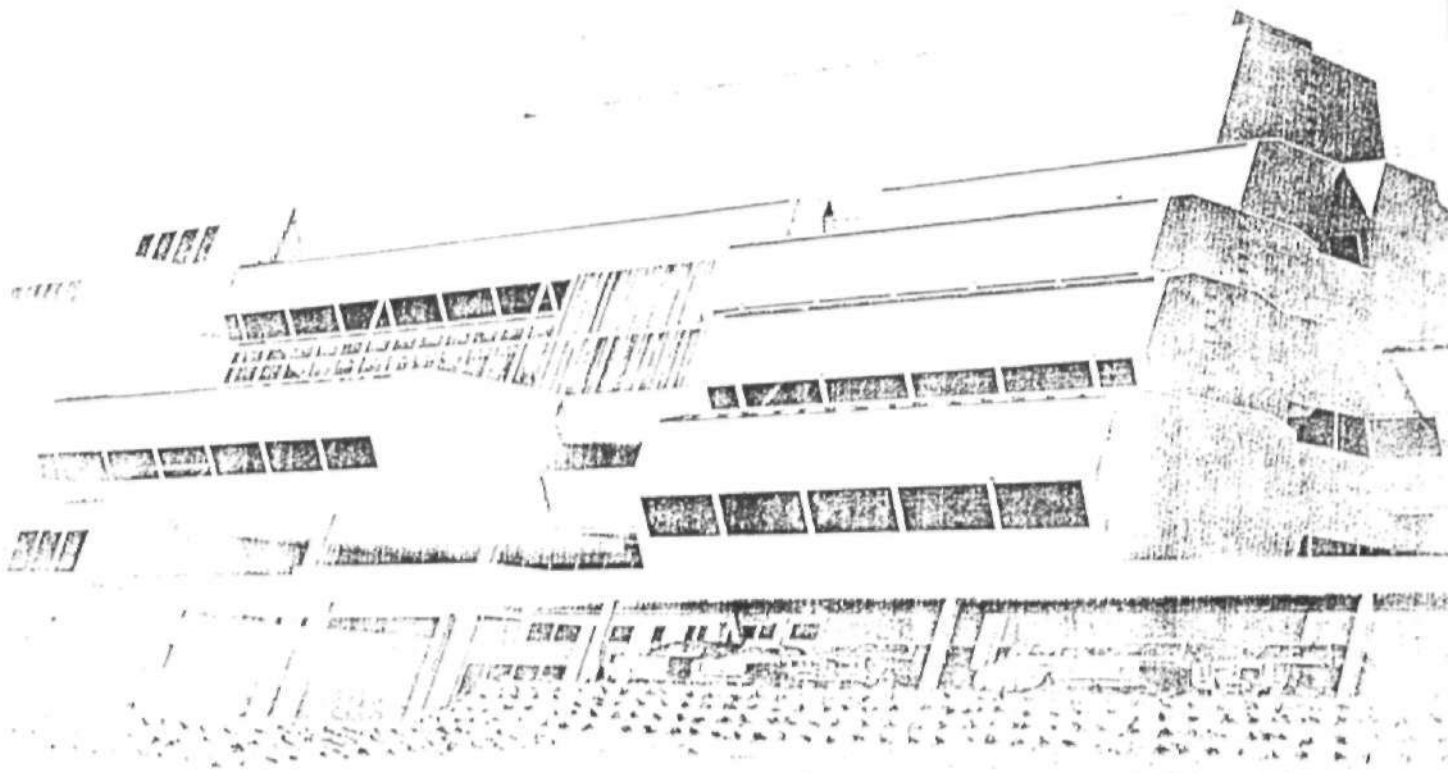
- Natural landscapes preserved by the use of the summit of the ridge, thus eliminating possibility of filling and infilling.
- Efficient pedestrian and vehicular circulation within and outside the complex respectively.
- Good positioning for animal quarters in relation to the laboratories.
- The complex is very flexible and can be expanded without disturbance of visual order.
- Above all the building has remained architechurally distinctive from the sense of exhilaration and spatial excitement it awakens in the mind of those who see it.

WELLCOME RESEARCH CENTRE, NORTH CAROLINA

FIGURE 4·1

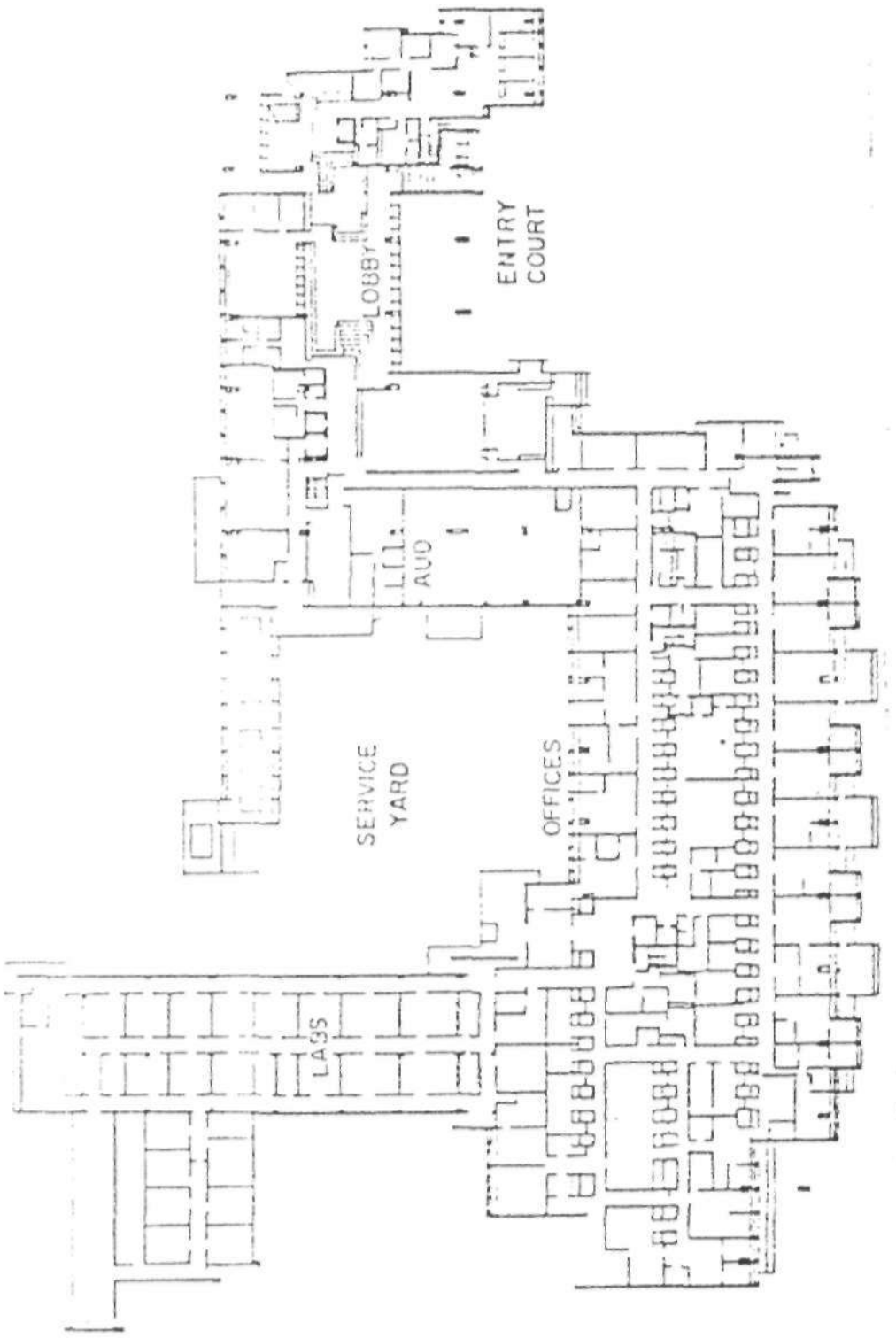


SITE PLAN (WELLCOME RESEARCH CENTRE)
SCALE 1: 3,000



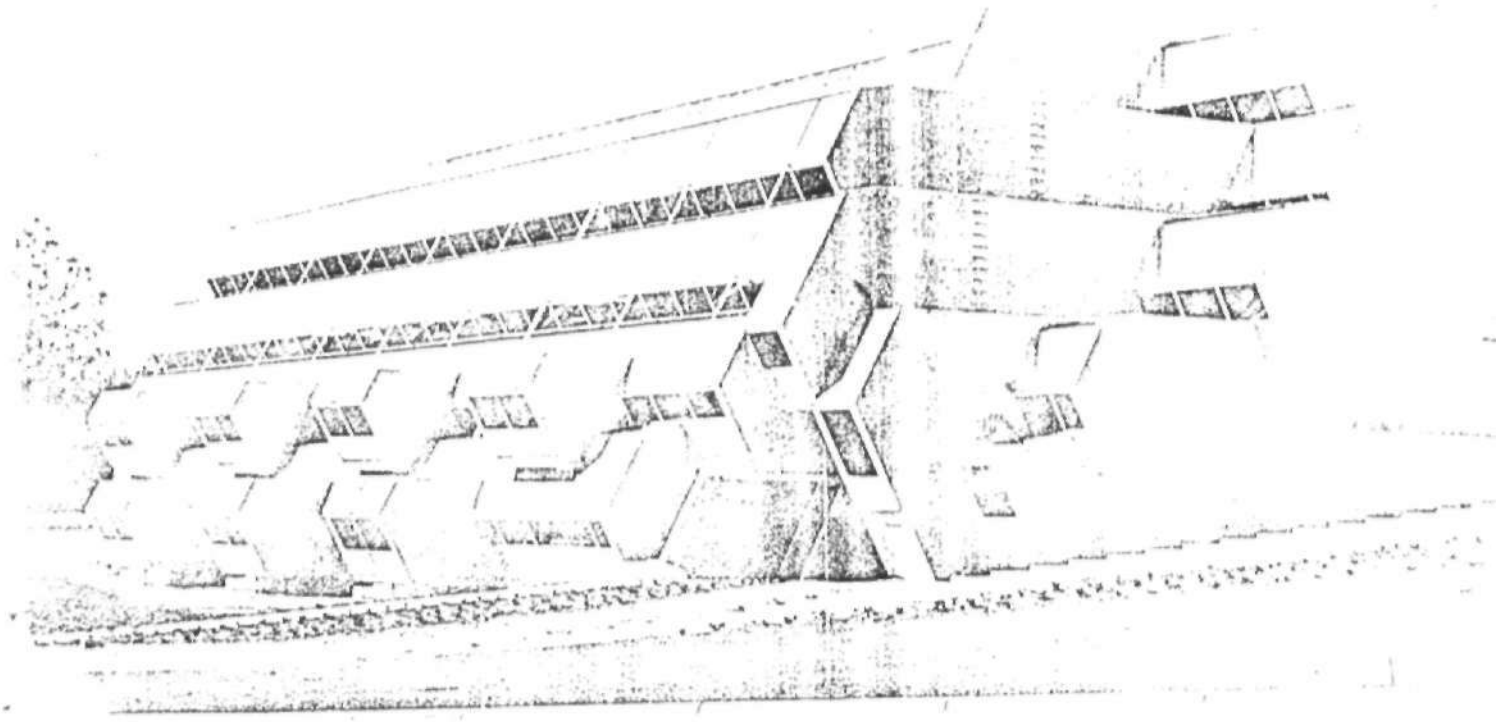
APPROACH VIEW (WELLCOME RESEARCH CENTRE) Fig. 4·2

WELLCOME RESEARCH CENTRE. NORTH CAROLINA U.S.A.



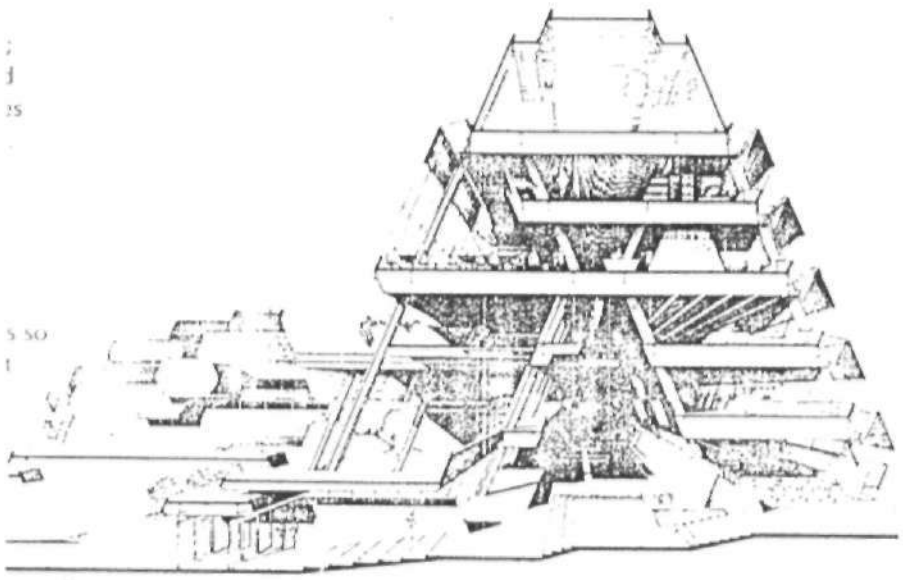
TYPICAL FLOOR PLAN

Fig. 4.3



Typical Elevation

Fig. 4.4



Typical Section Fig. 4.5

Disadvantages

The main disadvantage of this research centre is the complex nature of the building making both maintenance work on the building and the services very difficult.

The very compact nature of the complex would be a disadvantage in event of fire.

4.2 Faculty of Pharmaceutical Sciences, Ahmadu Bello University, Zaria, Nigeria
Architects: MaCgregor & Awani (Architects & Planners.

Location

The Faculty of Pharmaceutical Sciences, located in the main campus of Ahmadu Bello University, Zaria, consists of two major departments - Pharmacology and Pharmacognosy. The Faculty is strategically located near the Faculty of Veterinary and Human Medicine, since the three Faculties share some common facilities. The location is in accordance with Ahmadu Bello University Master Plan.

Objective

The Faculty started as a department in the Faculty of Science. As a result of acute shortage of pharmacist in the country, the department was upgraded to a Faculty of its own in 1977/78 session.

The aim was to provide training to young Nigerians to meet their increasing demand in the health sector. The Faculty is also expected to carry out basic research as might be necessary.

Planning

The complex is planned around a central court-yard which is used as herbal garden. The administrative block is a storey building while the other blocks in the complex are four storey buildings. The main store and chemical store are located on the ground floor. The Animal House is located just adjacent to the service yard.

The corridor space are not merely used for circulation but are used also for storage, thereby reducing space wastage.

Double loaded corridor are avoided as much as possible in order to ensure proper cross-ventilation. The teaching, office and research areas are all interwoven.

Structure

Reinforced concrete frame with concrete rib waffle floor slab were employed. Sand-cement block work were used for external walls and partitions. The ground floor was raised above grade. Concrete walk way with cluster screening were used. The

roofing material is corrugated aluminium roofing sheet bolted to steel roofing trusses.

The sun protection device consists of cluster to walkway and projecting concrete window level, with concrete cover at window side.

Services

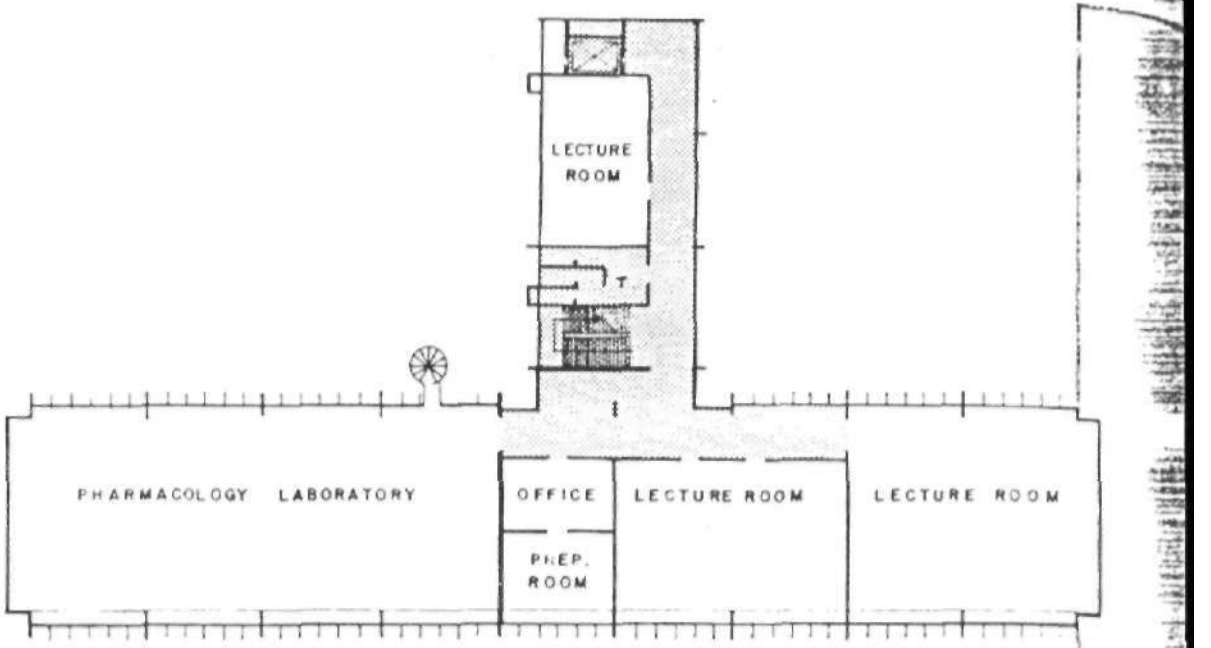
Air conditioning wall units were supplied to key spaces. Natural ventilation were employed in most of the teaching, office and even in some research areas.

Advantages

- Use of standard elements - standard elements were utilised for all components of the building including laboratory fitting, making repair and maintenance work easy. This also has an effect on flexibility.
- Proper utilisation of circulation areas - it serves as storage space for glasswares through the provision of built in cupboards.
- Double loaded corridor were avoided as much as possible, thereby improving natural ventilation and lighting. This also has an effect on safety in case of accidents.

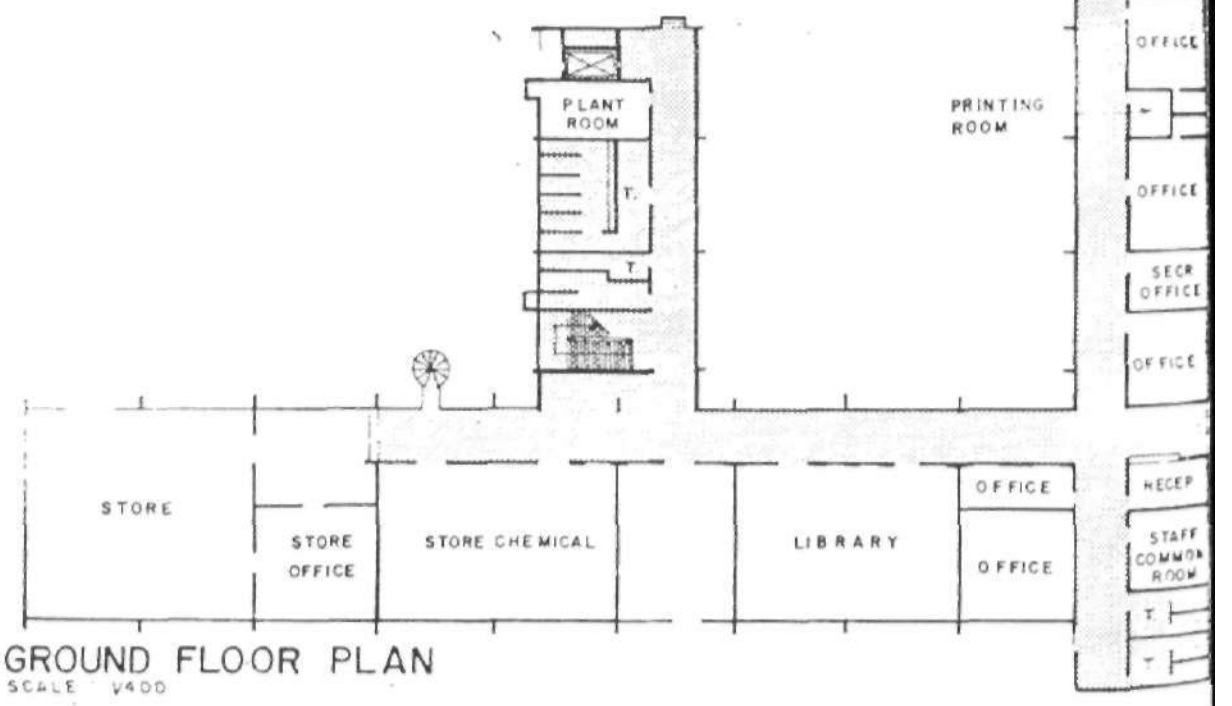
BLOCK (A) A·B·U· ZARIA

(A)



FIRST FLOOR PLAN

SCALE 1/400

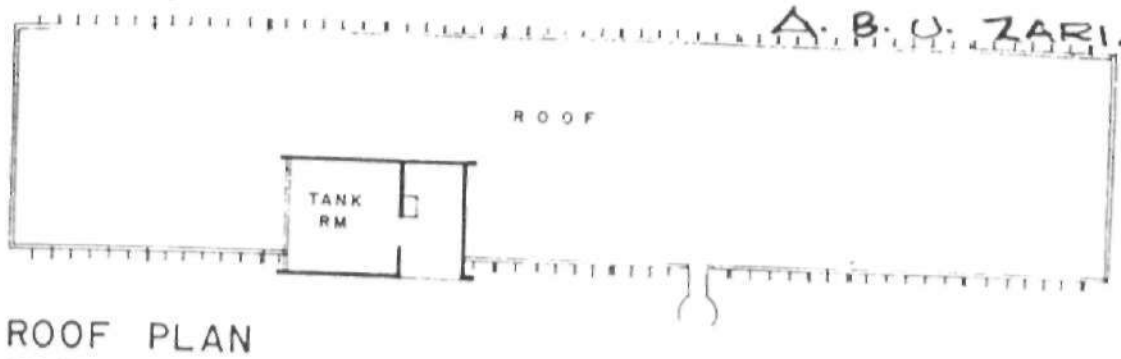


GROUND FLOOR PLAN

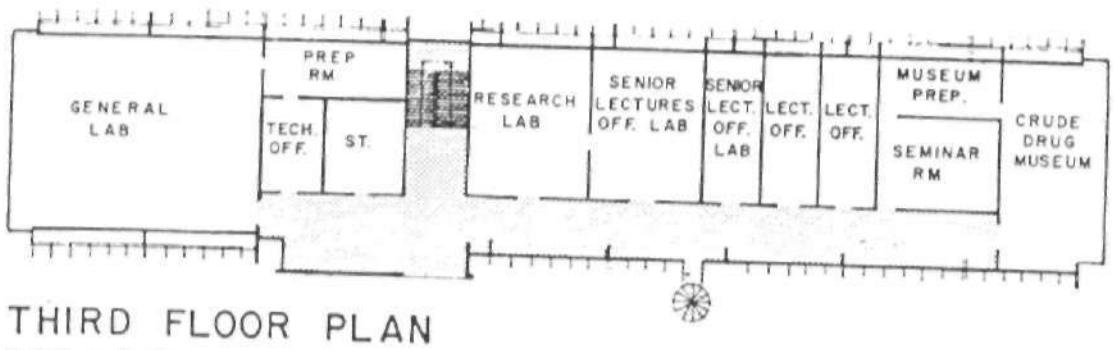
SCALE 1/400

FIG. 4.6

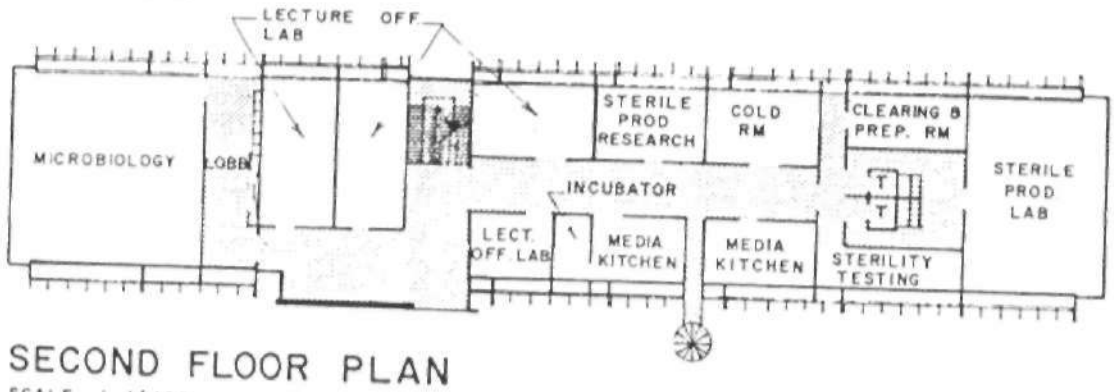
A.B.U. ZARIA



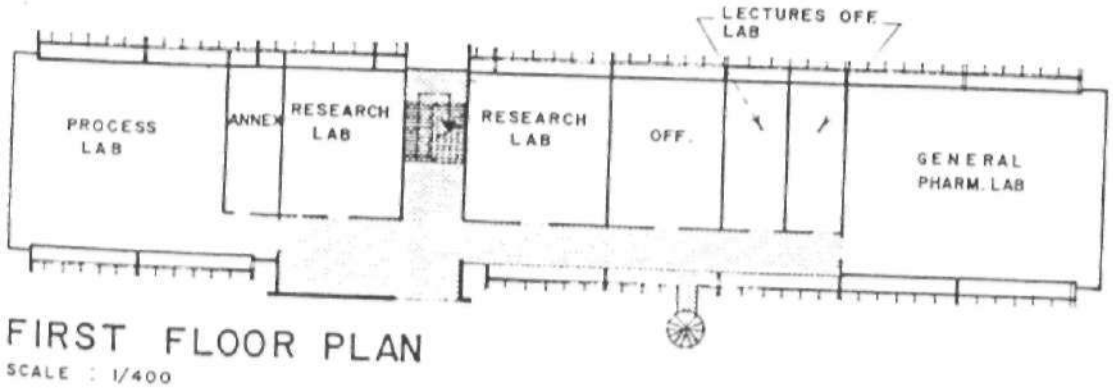
ROOF PLAN
SCALE 1/400



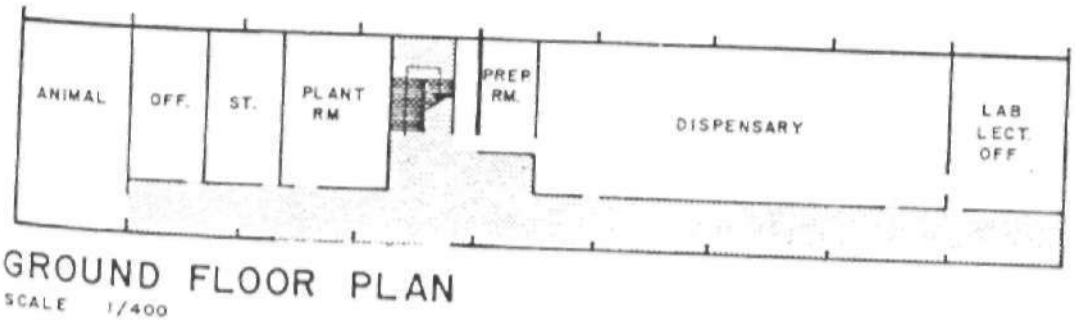
THIRD FLOOR PLAN
SCALE : 1/400



SECOND FLOOR PLAN
SCALE : 1/400



FIRST FLOOR PLAN
SCALE : 1/400

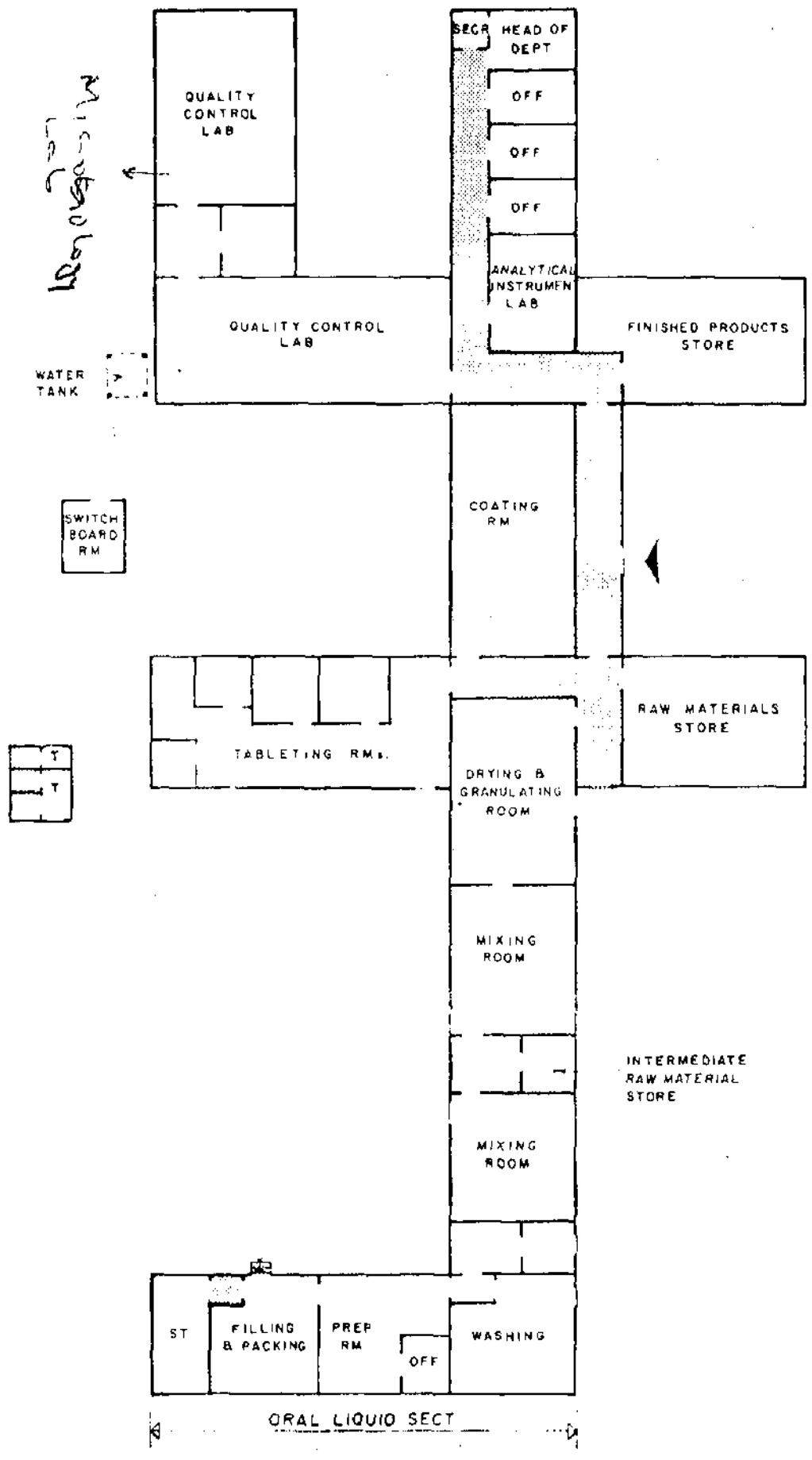


GROUND FLOOR PLAN
SCALE 1/400

Fig. 4.7

ABU TEACHING HOSPITAL

DEPARTMENT OF PHARMACEUTICS (5)

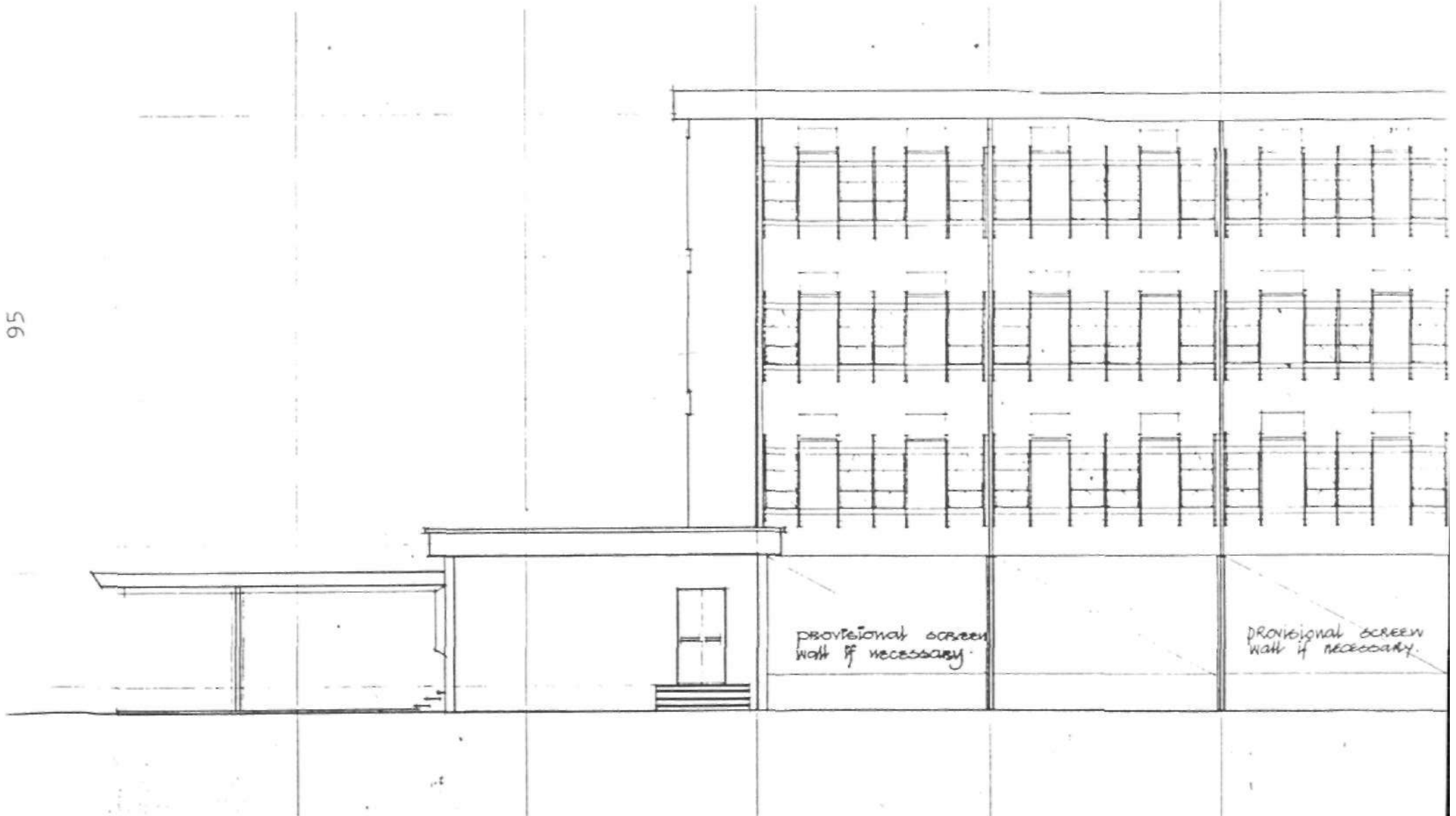


GROUND FLOOR PLAN

Fig. 4.3

FACULTY OF PHARMACEUTICAL SCIENCES. A.B.U. ZARIA

FG. 4.9



TYPICAL ELEVATION

Disadvantages

- There is no clear separation between research, and teaching spaces.
- The elevations is boring and monotonous - same elements and composition were employed for all the sides.

4.3 Parke, Davis & Company Research Centre,
Ann Arbor, Michigan
Architect: Skidmore Owings & Merril

Site Selection and Brief

The is also one of the world leading Pharmaceutical Company that is research oriented. This Research Centre is located in Ann Arbor adjacent to University of Michigan.

The brief consisted of departments such as

- Administration
- Research Laboratories
- Solvent storage shed
- Power plant
- High pressure laboratory
- Library
- Conference hall
- Cafeteria.

Other consideration in the brief was the client's wish to be near a research university and to establish an academic atmosphere.

Description of Functions

A two storey administration buildings is set in front of a three storey laboratory and a power plant. Access to the administration building front and rear, is at both floor levels. Upper floor access in front is by bridging from an embankment, in the rear, similarly, by straight to a mid-level terrace between administration and laboratory building. The administration building contains offices, library, cafeteria and auditorium.

The main laboratory building has three floors above a basement. Upper floor plans are similar to first plan. The basement contains a receiving dock, mechanical rooms, animal receiving, bottle and cage washing. First floor is divided into two functional areas, chemistry and pharmacology. The chemistry ends is built around a central mechanical equipment area with laboratory modules opening to an exterior corridor. The pharmacology ends contains animal rooms along a central interior corridor back to back with laboratories on the exterior corridor.

Structure

The buildings are framed in structural steel on reinforced concrete spread footings. Exterior walls are precast exposed aggregate panels with aluminium and glass curtin wall. Glass is solar gray plate and

double plate. Interior walls are painted plaster and glazed structural units with occasional exposed aggregate panels. Interior partions are pre-fabricated aluminium and glass or wood. Floors are reinforced concrete with plastics or ceramic tile.

Service Distribution System

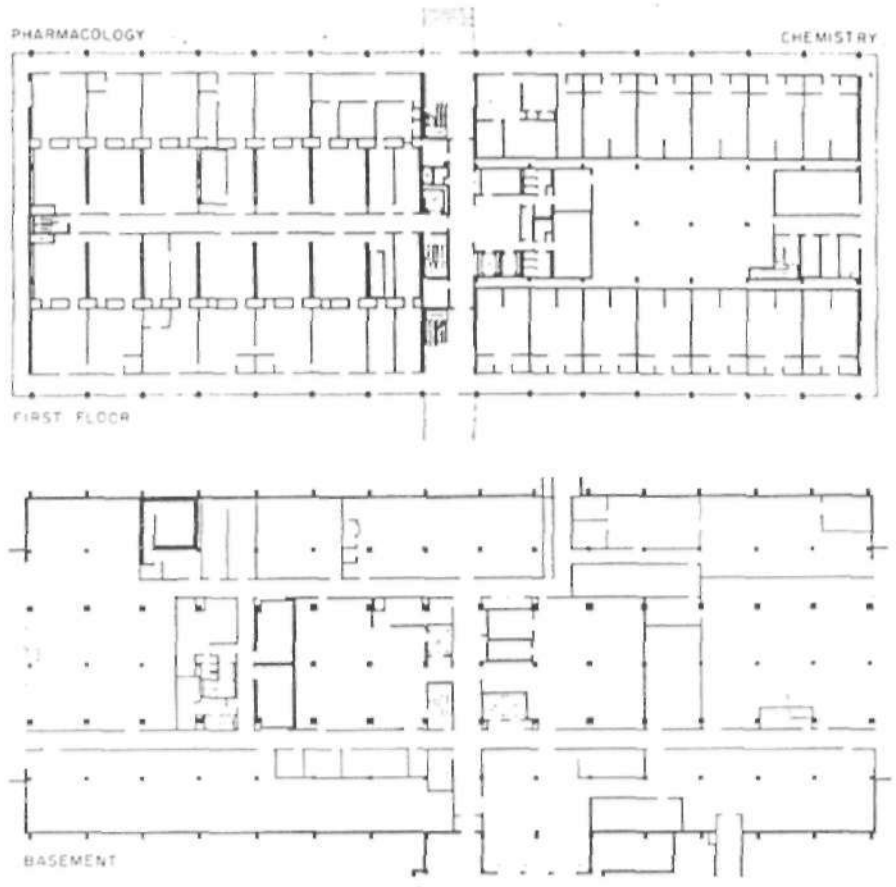
The offices are air conditioned with reheat low pressure induction units other areas through conventional ceiling diffusers. Vertical distribution system is utilised in the laboratories. The perimeter corridor in the laboratory building is heated and air conditioned by vertical discharge air grilles at the base of windows. Air is exhausted through fume hoods. The power plant provides heating and process steam, chilled water and standby electric current.

Advantages

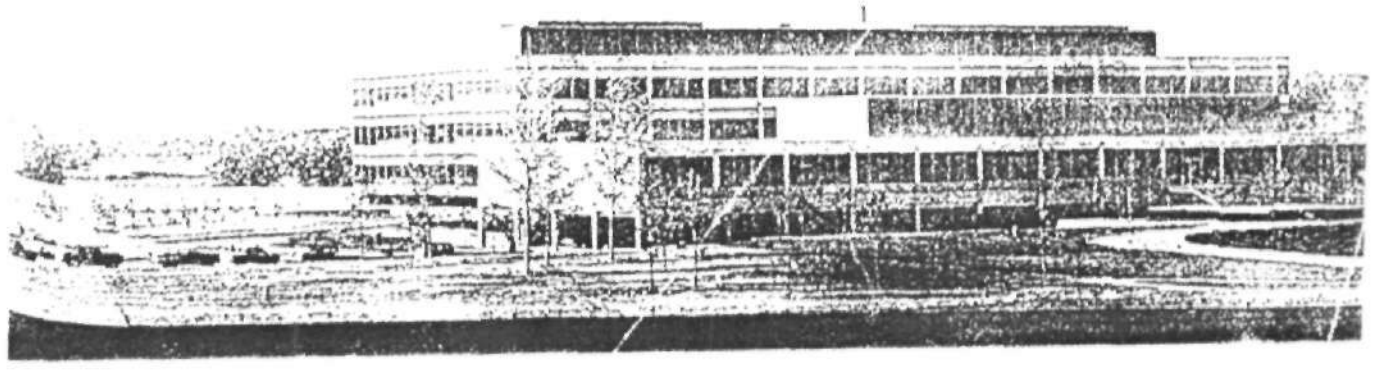
- Pleasant and economical use of terrain.
- Good and efficient positioning of services. The services provided at the basement would not disturb areas where tranquil are needed. The overall services line will be easy to maintain without disruption of work in the laboratory.
- The terrace between the laboratory and administrative building is very pleasant.

FIGURES 4·10

Parke, Davis & Company

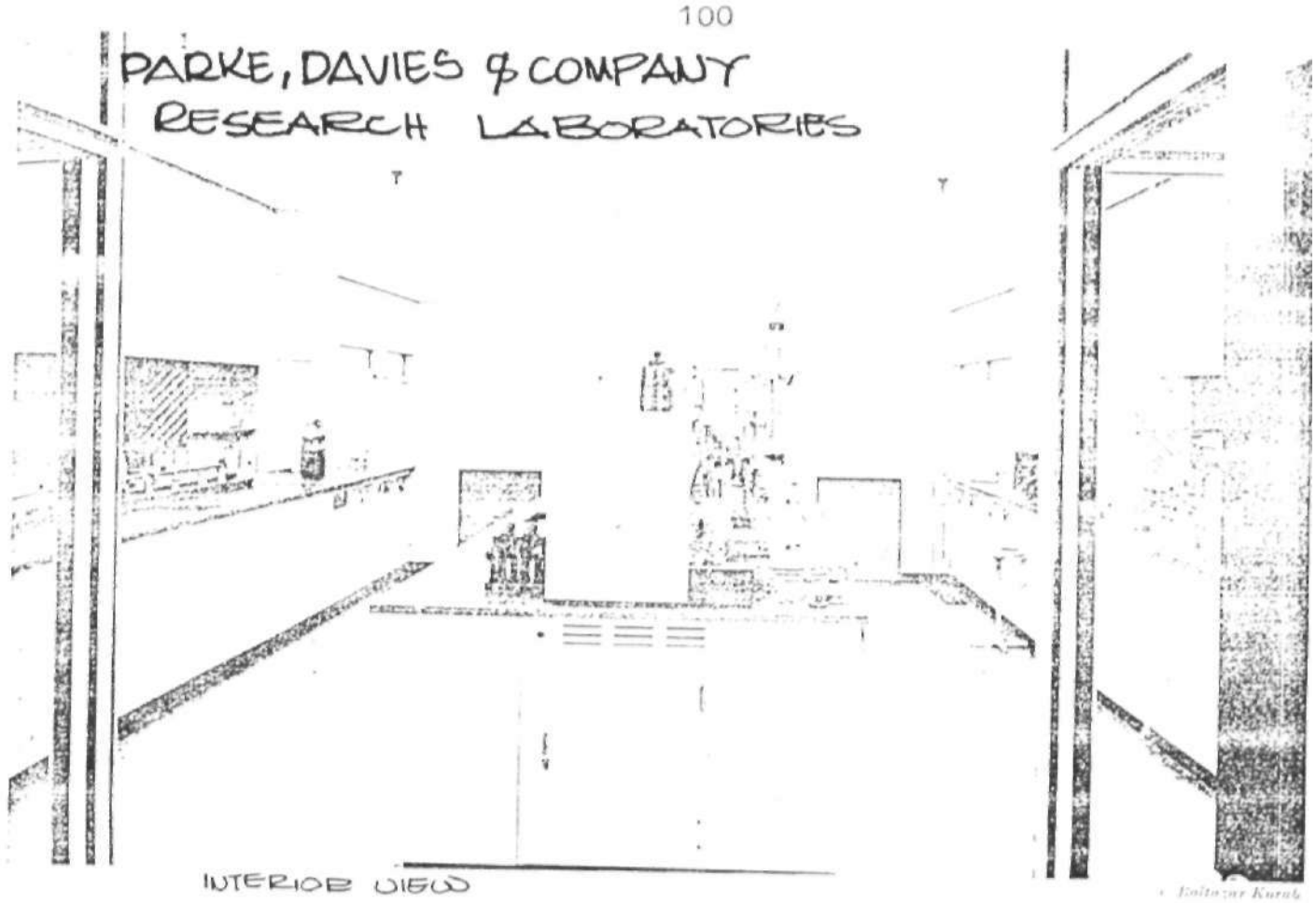


TOP: FIRST FLOOR PLAN OF LABORATORY BLOCK
BOTTOM:- BASEMENT FL. PLAN

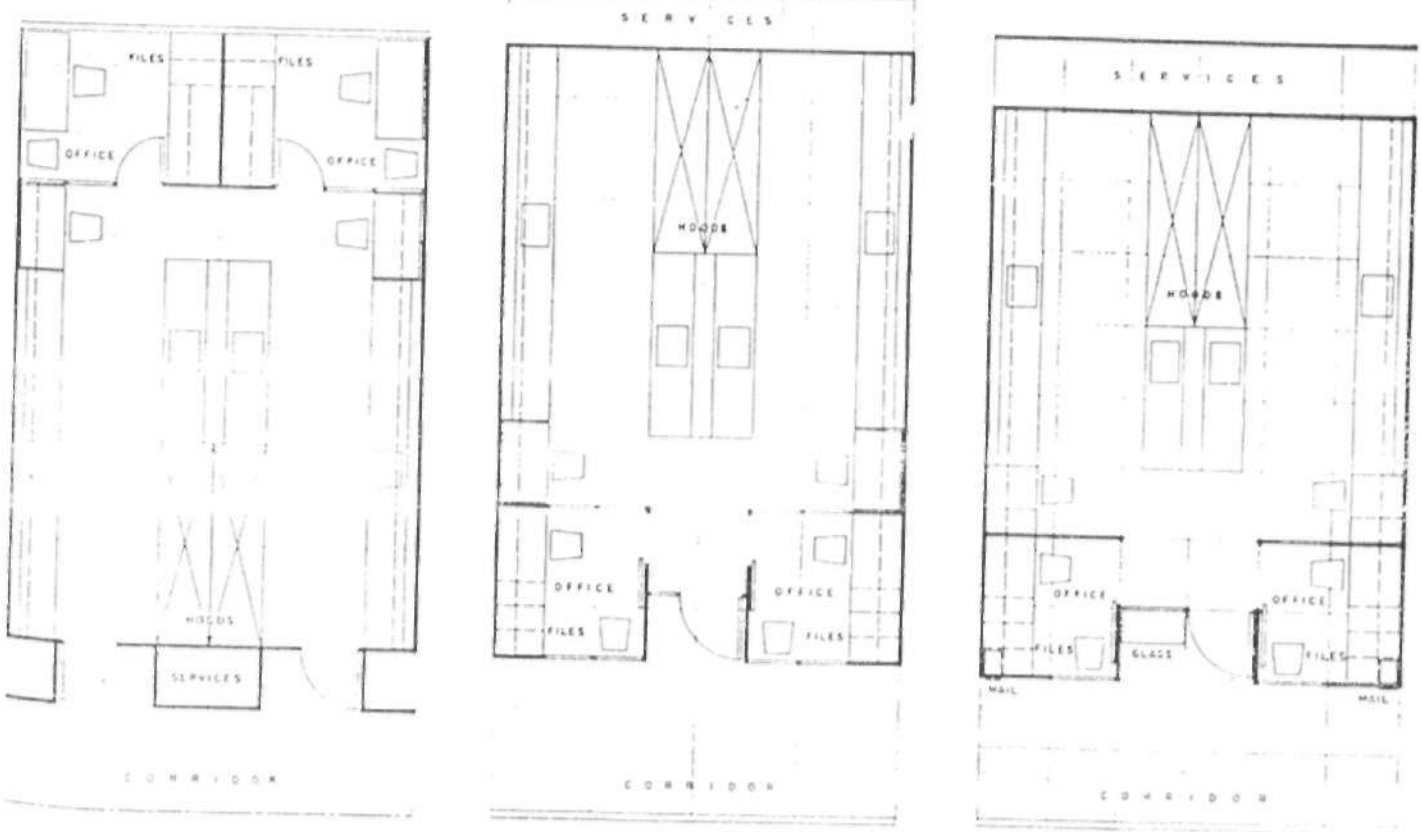


TYPICAL VIEW OF THE RESEARCH CENTRE

PARKE, DAVIES & COMPANY
RESEARCH LABORATORIES



INTERIOR VIEW



— 5'-0" MODULE, INTERIOR CORRIDOR

LAB AREA	600 SF
BENCH	55 LF
SHELF	45 LF

— 5'-0" MODULE, EXTERIOR CORRIDOR

LAB AREA	600 SF
BENCH	55 LF
SHELF	45 LF

— 5'-6" MODULE EXTERIOR CORRIDOR

LAB AREA	588 SF
BENCH	49 LF
SHELF	35 LF

TYPICAL RESEARCH LABORATORIES

FIGURE 4·11

- Good link between animal quarters and pharmacology laboratory.
- The campus plan adopted will provide for easy expansion without disruption of functions.

Disadvantages

- Poor circulation in the administrative building.
- Ventilation and lighting are purely artificial in most spaces.

4.4 Hoechst Research Centre, Franfurt (M) - Hoechst, West Germany

Architect: Professor Henn of Braunschweig

The Farbwerke Hoechst AG is a firm with a world-wide reputation for chemical products, head-quarters are at Frankfurt (M) - Hoechst. In course of development, the research laboratories were widely dispersed amongst the Hoechst factories, this was uneconomical and had the serious disadvantage that research workers were in isolated groups.

Site Selection and Brief

310008

The Research Centre is on a 74-acre of terrain on the opposite side of River Main and connected to the existing site by company-owned bridge. The site has some rural seclusion.

The brief consisted of departments such as

- Administration
- Drug research laboratory
- Synthetics research laboratory
- Dyestuff and fibre research laboratory
- Analytical chemistry laboratory
- Pharmacology laboratory
- Pilot plant for experimental production.

Description of Functions

There are five research laboratories each 101 by 22.5m, those are for fundamental, synthetics, dyestuff and fibre, and drug research. Each laboratory has a pilot plant building 48.75 by 18.75m for experimental production. All the buildings are three storeys and basement, they are inter-connected by enclosed corridors which have two storeys and basement. In addition, there are six laboratories of similar size specially designed for physics, analytical chemistry, pharmacology and engineering research.

Planning

Each of the laboratory was planned for two scientist and modules were used for all the laboratory. Each laboratory occupies three modules. The columns are at 3.33m centre, the floor to ceiling height is 3.2m, and the floor to floor height is 4.2m. There

is one window 2.57m wide per module of 3.33m. All the components of the laboratory are standardised, so that they can be replaced when damaged.

Service Distribution System

Horizontal sub-main distribution system is adopted for all the laboratories with pipes and ducts running through holes in the cross-beams. Exhaust fans and lift machinery are house in the roof space. Some of the services brought to the laboratory area include high and low pressure steam, compressed air, burner gas, nitrogen, drinking water and 60kva of electricity supply. Fumes are exhausted through a slot formed by the back baffle which runs the full length of the cupboard.

Structure

The buildings have a pre-fabricated reinforced concrete frame and brick external walls, the internal walls are brick, plastered, with fairly extensive areas tiled. Suspended ceiling are used throughout the laboratory buildings to conceal the service pipe and ducts. The suspended floors of the pilot plant are precast concrete slab set in asplit cement and supported on steel joist which are bolted to the columns. This device allows portion or whole of the floor to be removed and replaced with another.

Advantages

- The site has been located in such a place that services can be drawn from an existing site.
- The use of standard elements has enhanced flexibility in the whole of the complex.
- Each laboratory building dealing with different areas of research has been equipped with a pilot plant. This allows research result to be put on experimental production.
- The use of two man-laboratory would ensure better exchange of ideas and continuous manning of the laboratory. This will also allow most equipment to be shared.
- The research centre was planned on basis of separate building, this will reduce damage in event of fire. This will also improve cross-ventilation.

Disadvantage

- The service pipe reticulated in beam holes within the laboratory will disrupt work in the laboratory below in event of maintenance work.

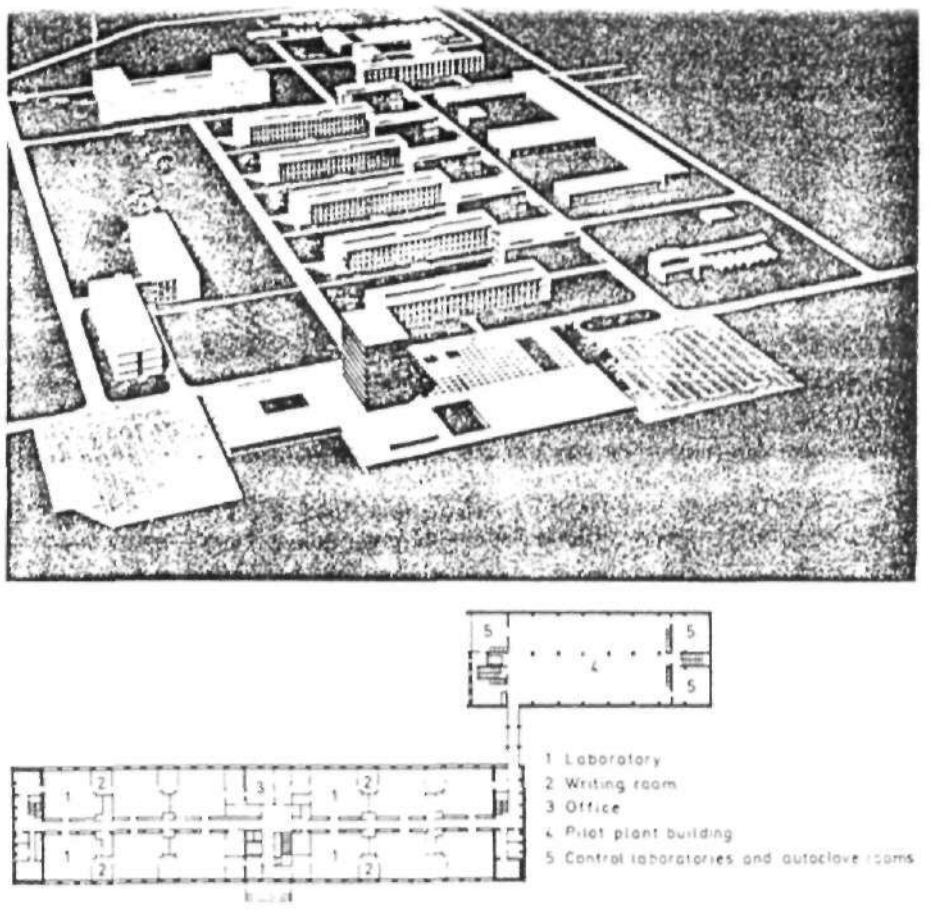
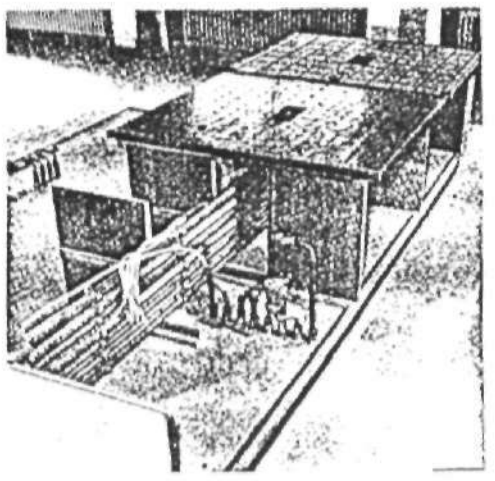


FIGURE 4·12 *Model of the site development, and a typical floor plan of a* 101·1 *by* 22·5 *m laboratory and* 48·75 *by* 18·75 *m pilot plant building—Hoechst Research Centre, Frankfurt (M)-Hoechst, West Germany.*

SERVICES



(a) Laboratory bench showing prefabricated panels, isolating valves, and construction of tiled bench top.

FIG. 4·13

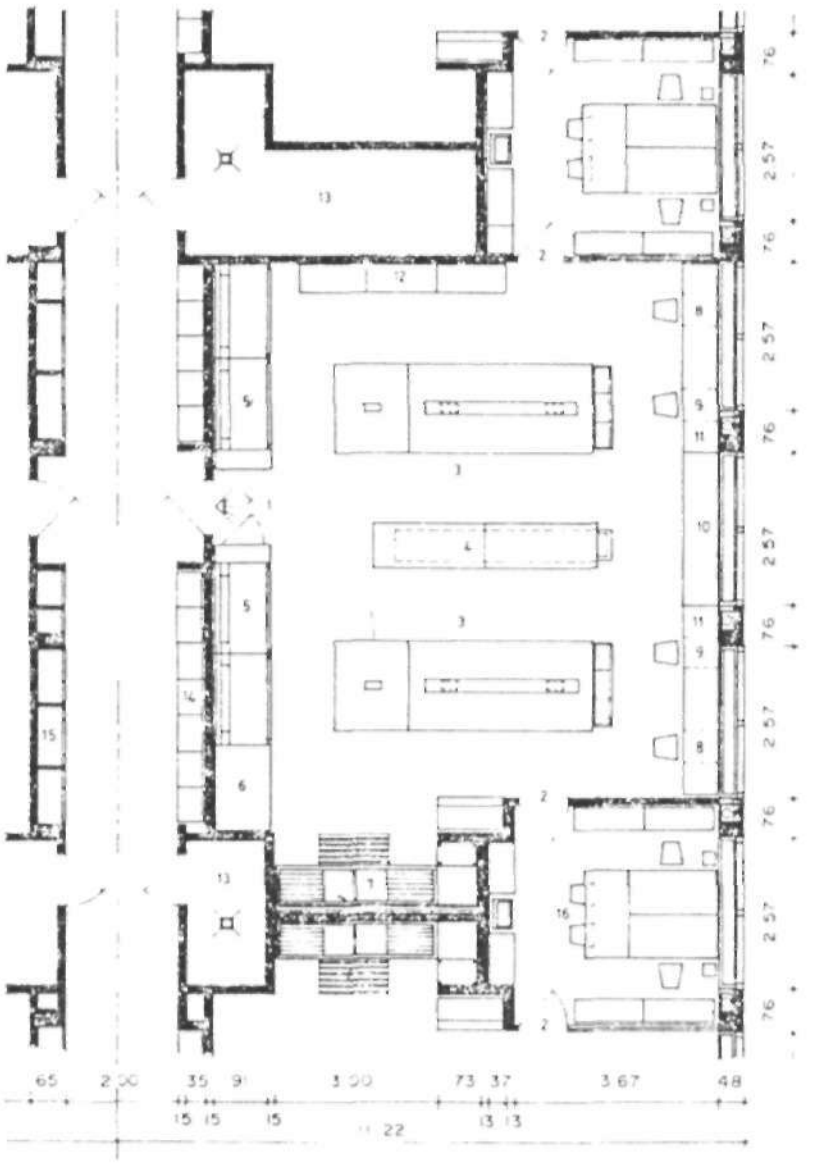


FIGURE 4.14 *Layout of a basic laboratory – Hoechst Research Centre, Frankfurt (M)-Hoechst, West Germany.*

Chapter 5

SITE AND SITE ANALYSIS

5.0 Site Location

By nature and scope of the centre being proposed which is directly responsible to the Federal Ministry of Science and Technology and ultimately responsible to the Federal Government, location must be considered in the interest of the nation. Therefore the ability of the centre to function well and meets its set down objectives must over-ride any political or ethnic implications.

Practically, the centre requires a quiet, noise-free, vibration-free, pollution-area and land readily available for substantial expansion area. A peripheral area within any part of the country which is free of industrial developments and satisfies all the requirement would be appropriate.

The proposed centre being the first of its kind in Nigeria should have probably be located at the Federal Capital Territory. However, the main problem in the way of siting the centre at the Federal Territory is lack of technical infrastructural facilities, manpower and other allied research institutions to which it can liaise for initial take-off and effective functioning.

An alternative site would be chosen outside the Federal Territory based on its own merits. The selected site would be used as a "testing ground" for the proposals. Factors to be considered in the selection of the alternative site include the following:

(i) How close the area is in terms of amenities and available manpower to that of the Federal Territory.

(ii) Possibility of future incorporation of pharmaceutical manufacturing company into the functions of the proposed research centre.

(iii) How central the location is on the Nigeria regional setting - "centrality", good and tolerable climate, land availability and adequate water supply, physical planning convenience, security and multi-access possibility, for easy road, rail and air communication links with other parts of the country especially other research establishments and the universities

5.1 Analysis of Alternative Location

Zaria has been considered as an alternative location of the research centre. Each of the criteria for selecting a feasible location for the centre will be considered in order to appreciate how satisfactory.

(i) The operational take-off of any research centre is usually constrained by staff availability, building facilities, equipment and financial control. Proximity to Ahmadu Bello University and Chemical/Leather Research Institutes would offset some of these fundamental constraints until the centre has been well established. Other advantage include administrative and technical support staff for the various departments, use of established pharmaceutical research equipments in the Faculty of Pharmaceutical Sciences, faster harmonization between pharmaceutical research projects and related procedure already existing in the university and those to be embarked upon by the centre for a better contribution towards advancement of pharmaceutical research.

(ii) The establishment of petro-chemical industry at Kaduna will lead to production of suitable raw materials for pharmaceutical manufacturing, Zaria being very close to Kaduna will make a suitable location for the pharmaceutical industry which can be easily incorporated with the research centre being proposed.

(iii) Zaria is reasonably positioned to serve the Northern Nigeria and indeed the whole of Nigeria. The climate is also very conducive for learning and research work.

SITE LOCATION AND SELECTION



Fig. 5.1

5.2 Location

The site is situated along Zaria-Sokoto Road. It is located just after the Ahmadu Bello University Teaching Hospital and shares boundaries with the hospital.

5.3. Site Characteristics

5.3.1 Geology

The site have older alluvium and young laterite, both undifferentiated. Bedrock is exposed in some places. Older laterites exists towards stream bed (towards the south of the site). It has adequate strength to withstand any engineering construction.

5.3.2 Soil

One of the most important considerations in the site planning processes is soil patterns and their ability to support development activities. Soil is the natural medium for plant growth at the surface of the earth and is also the usual foundation on which building rest. The predominance soil on the site are still brown and red-brown sandy clays and compact silty sand. Older laterite are red-brown, cellular, free from impurities. Younger ones are browner, less cellular, less free of impurities. They are heavy and relatively difficult to work, tending to become

waterlogged with heavy rain and to dry out and crack during the dry seasons (1).

5.3.3 Topography/Vegetation

The proposed site is relatively flat. The highest contour line in the area extends at about 710 metres above sea level and the lowest is about 670 metres. There is however, a downward slope towards the west. There is no abrupt rising of the land that can impede views and rock outcrops are absent.

The site lies in the Northern Guinea Savanna zone, it is covered by savanna and orchard bush with occasional trees dotted round the terrain. Important trees found on the site include acacia, cotton silk, mango and 'dorowa'.

5.3.4 Obstructions

Unauthorised execations leave wide gullies 2-4 metres deep in some places.

5.4 Geographic and Climatic Data

Zaria is within the hot and humid climate category that most of Nigeria are located. The humid-tropical climate is restrictive, characterised by extremes of heat and humidity. It has tremendous influence on the layout and design of buildings and

landscapes. Under the climatic factors elements like rainfall, temperature, humidity, discussed in relation to the site. These elements are very important indicators of the types of structures to be put up on the site.

5.4.1 Rainfall

Zaria lies within a region which has a tropical savanna climate with distinct wet and dry season (2). Effective wet season occurs in high sun period during May to September. The dry season which falls into the month of November to February, is practically rainless. The first rain of the year falls as thunderstorm showers in March or April. The frequency of these showers increases during May and June. The heavy showers are accompanied by strong gusty winds which sometimes create havoc by blowing away thatched roofs and uprooting trees especially in rural areas (3). Monthly rainfall increases from March in each successive month till August which is the wettest. The rainfall decreases in September and in October which is actually a transitional period when normally the wet season ends and dry season begins. Rainfall during the month is very unpredictable. The heavy rainfall during the month of August necessitates a proper drainage system that can withstand large volumes of water during this period. The roof structural system should be carefully

chosen to withstand the strong gusty winds that accompanied early rain.

5.4.2 Temperature

The temperature of Zaria goes up as the precipitation decreases and reaching peak of 75°F and above during the month of April. A great heat is experienced during this period. The temperature is low in December and January. Range of temperature normally exceeds 20°F. Proper ventilation would be of importance to building on site and most of the trees on site would be retained to improve micro-climate.

5.4.3 Humidity

The relative humidity in Zaria region is high during early hours and low at noon throughout the year except occasionally during the wet season when there is rainfall. Materials to be used on site should be capable of retaining a lot of moisture.

5.4.4 Winds

Orientation and design of buildings are greatly influenced by wind speed and direction. The climate of Zaria region is influenced by two major wind currents. The south-west trade winds which are warm and moist and the north-east trade winds which are hot and dry. These wind currents give rise to the major seasons. The south-west winds blow from April to October and

the north-east trade wind blow from November to March. A cold, dust-laden wind, the harmattan, blows during November to February months. The wind speed are consistent throughout the year.

5.4.5 Sunshine

The sun altitude combined with the direction of the wind during the course of the day, determines the most favourable orientation of structures, their shielding or exposure to sun, types of windows, building materials and so on. Zaria region is subjected to strong sunlight and high reflectivity most of the year except during periods of high precipitation when the hours of sunshine are least.

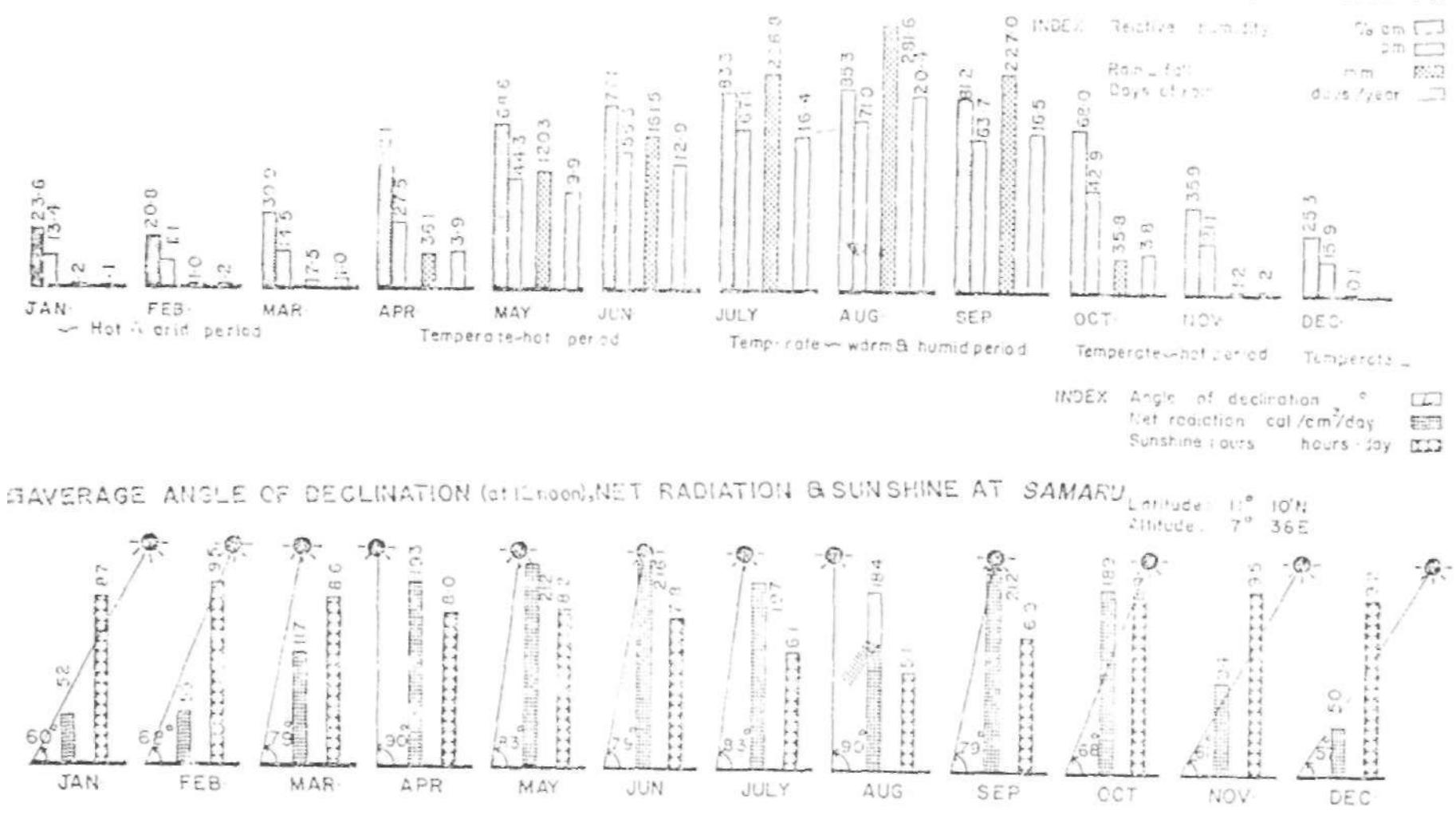
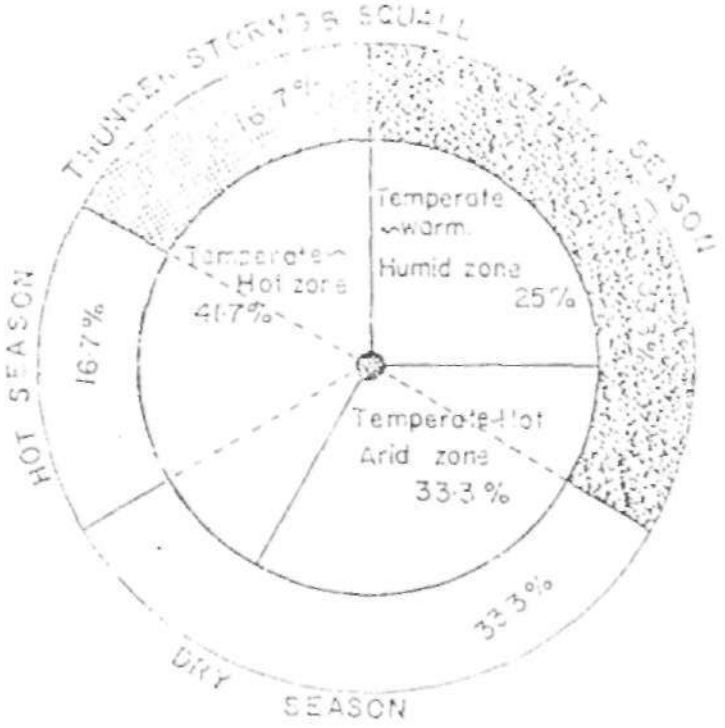

AVERAGE MONTHLY RAINFALL AND DAYS OF RAIN AT SAMARU
FIGURE 52
CLIMATE
INDEX Relative humidity %
Rainfall mm
Days of rain days/year
JAN
FEB
MAR
APR
MAY
JUN
JULY
AUG
SEP
OCT
NOV
DEC
Hot & arid period
Temperate-hot period
Temperate-warm & humid period
Temperate-hot period
Temperate
AVERAGE ANGLE OF DECLINATION (at 12 noon), NET RADIATION & SUNSHINE AT SAMARU
INDEX Angle of declination °
Net radiation cal/cm²/day
Sunshine hours hours/day
Latitude 11° 10'N
Altitude 7° 36E

FIGURE 53 CLIMATE

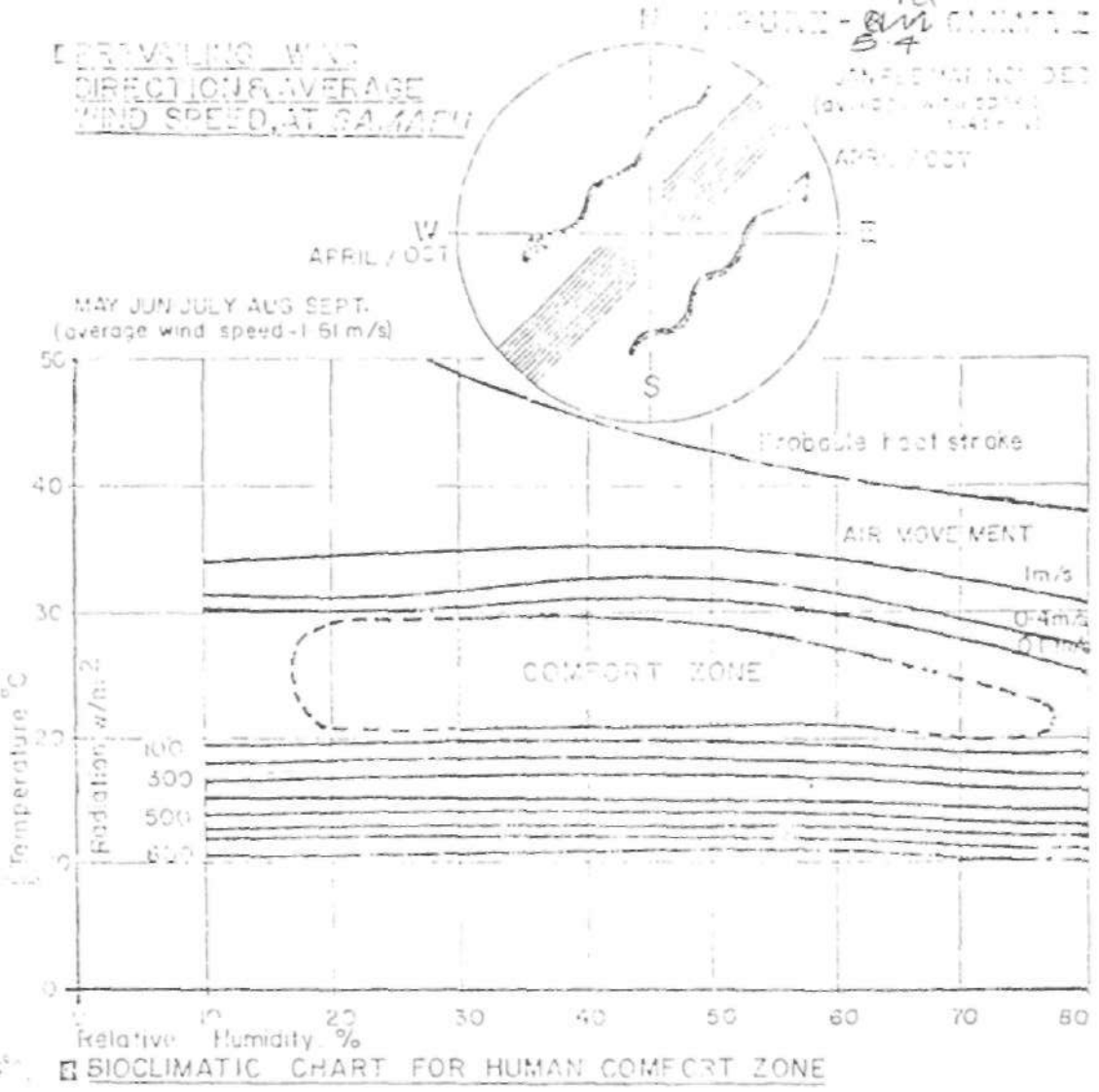
MONTH	MEAN TEMPERATURE °C	Classification	MEAN RELATIVE HUMIDITY %	Classification	MEAN TEMPERATURE Min °C	Max °C	Variation °C	VARIATION Classification	GENERAL CLASSIFICATION	INDOOR COMFORT CONDITIONS *
January	22·2		68·5		14·0	30·4	16·4		Temperate-hot, cold	Moderately uncomfortable conditions
February	24·4		63·9	Dry	16·0	32·7	16·7	Temperate ~ hot		
March	27·5		22·7		19·5	35·3	15·8			
April	28·8		33·8		21·7	35·8	14·1			
May	27·5		56·4		21·2	33·2	12·0		Temperate-hot, humid	Comfortable conditions during afternoons and nights.
June	25·5	Warm	66·7		19·9	30·8	10·9			
July	23·9		75·2	Humid	19·5	28·4	8·9	Warm ~ hot	Warm ~ hot, humid	Moderately uncomfortable
August	23·5		78·1		19·3	27·7	8·4			
September	24·2		72·4		19·1	29·2	10·1			
October	24·9		55·4		17·6	31·4	13·8		Temperate ~ warm	Comfort conditions during afternoons & nights
November	25·6		28·5	Dry	15·7	31·6	15·9			
December	22·3		20·6		14·0	30·6	15·6	Temperate ~ warm	Temperate ~ warm arid	Moderately comfortable.

* CONSIDERING WIND SPEED LESS THAN 1m/s AND RADIATION LESS THAN 100 W/m²



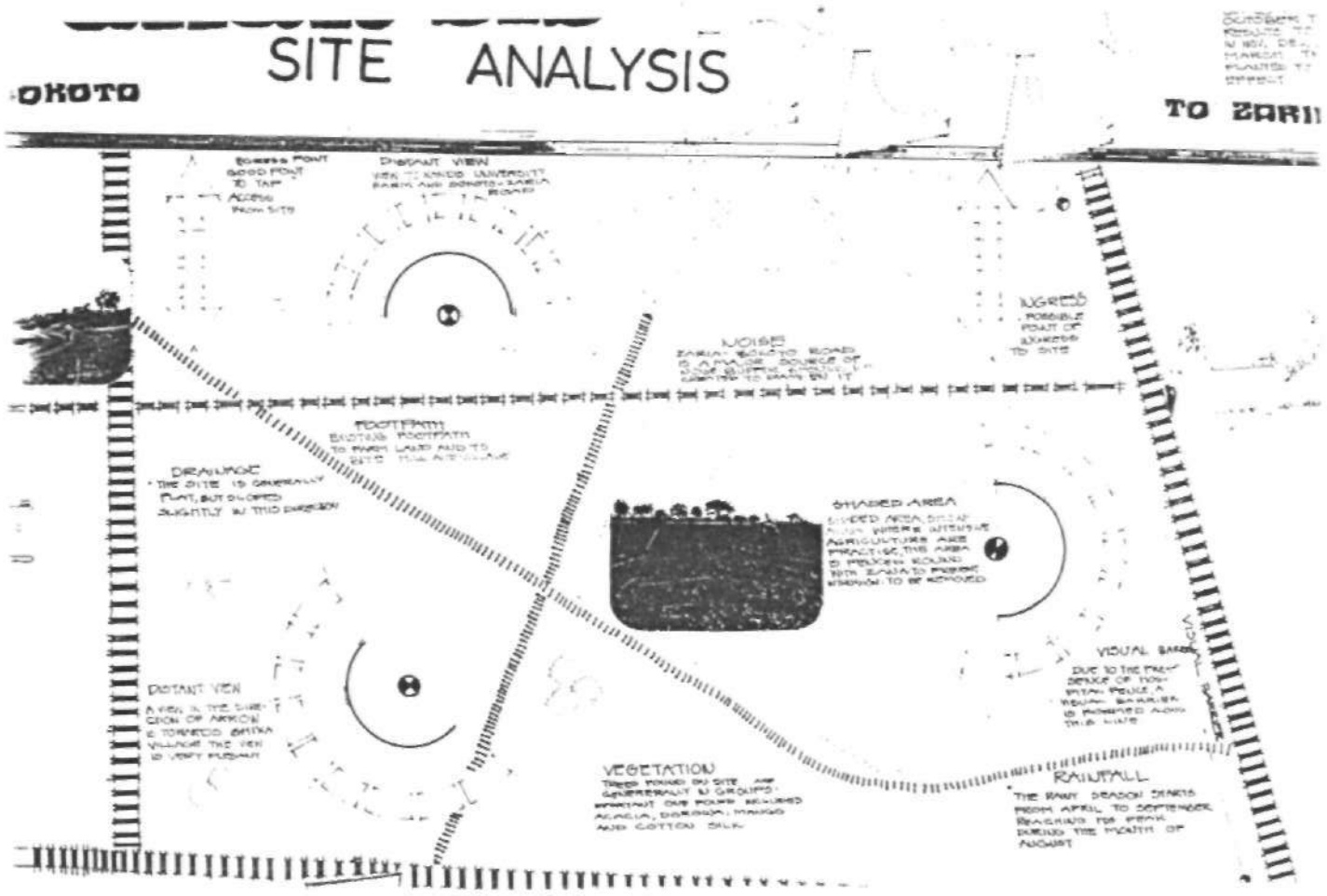
I ANNUAL AVERAGE CLIMATIC CONDITIONS & CORRESPONDING SEASONS AT *SAMARU*





II BIOCLIMATIC CHART FOR HUMAN COMFORT ZONE

SITE ANALYSIS



REFERENCE FOOTNOTES

1. Olowu, J. "Preliminary Investigation of the Ground Water Conditions in Zaria". Sheet 102 SW, Geological Survey of Nigeria, Report 1462, 1967, p. 4.

2. Keay, R. W. J. "An Outline of Nigeria Vegetation", Lagos 1969.

3. Hore, P. N. "Weather and Climate" Zaria and its Region, Ahmadu Bello University, Department of Geography, 1976, p. 47.

4. Institute of Agricultural Research, Meteorological Observations, Samaru-Zaria

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Chapter 6

6.0. DESIGN REPORT

6.1 Problem Definition

In the execution of a pioneer project like this in Nigeria, the usual problem is the lack of architectural precedent on which to build. It therefore becomes necessary to use an existing facility in the developed countries like Britain, Germany or United States as an experimental study model. Case studies from these countries were analysed and the data obtained there from synthesize to suit Nigeria's perculiar situation.

Also in drawing up the requirements for the centre, I have had to hold series of discussions, more in form of lecture with pharmacists and other allied professionals in both the academics and pharmaceutical companies. This also enabled me to synthesise what aspects of pharmaceutical research will be beneficial to Nigeria.

6.2 Brief

In preparing the design brief of an applied research establishment, four basic facilities can be identified to effect efficient functioning. These are:

1. Administrative facilities
2. Ancillary facilities
3. Research facilities
4. Service facilities

Addition of experimental testing facilities might become necessary depending on nature of research (as in this case).

1. Administrative services
   - Services required for the smooth and efficient functioning of all the research and development projects. There are two types viz:

Management:

- This is the principal administration building accommodating the following:

1. Director's Office - with the necessary reception and secretarial suite and a meeting room or board room.
2. Deputy Director's Office - with secretarial suite.
3. Administrative Secretary Office - same as above.
4. Visitors' Reception - with reception desk and waiting area.
5. Closed exhibition space.
6. Board room - for board meetings, etc.
7. Senior staff lounge.

Administration:

- This takes care of the actual day to day running of the centre. It requires spaces for the following:
  1. Accounts Department
  2. Audit Department
  3. Purchasing Department
  4. Personnel Department

Information Services:

- A logical extension of the library facility to provide a national information advisory services. They include the following:

Publications - office accommodation for editor and staff.

Publicity - publicising the results of research, presenting them to the media organisations, and participating in or even mounting exhibitions of centre's work.
Office space for public relations officer and support staff.

Translations - translates research findings into the major languages. Office space only.

Codes and standards - provides consultancy services and professional, technical and scientific data relating to pharmacy to the pharmaceutical industry as well as federal and state government ministries responsible for drug procurement. Office accommodation only.

Auditorium - for organising conferences and seminars, with some occassional public lectures and symposia and workshops. Capacity - 200-250 people.

ANCILLIARY FACILITIES

- This houses services required by all part of the centre. It consists of:

Computer Unit - used by research and other staff for calculations, data analysis and storage of pharmaceutical information. Spaces required includes computer room, machine (plant) room and office accommodation for analysts, programme writers, operational engineer and receptionist.

Library Services - essential source of reference for any research organisation. It includes the following parts:

1. Audio-Visual Unit - Audio visual store, study carrels and office accommodation for staff.
2. Photographic Unit - Photocoping room, photographic studio, dark room and offices for staff.
3. Reproduction Unit - Publishes results of works carried out by the centre. It consists of bindery workshop, printing department (with dark room), stores for raw materials and finished products and office space for staff.

4. Book Stacks - For books and journal/other reference materials.

5. Reading Areas - For research and other staff as well as public.

6. Office spaces - For Librarian, and other staff.

Catering Services - It serves the whole of the centre. Should have capacity of 60-80 seats, spaces required include store, kitchen, dining areas.

RESEARCH FACILITIES

- Crude drug development unit
- Process department
- Chemical department
- Pharmacology/Toxicology department
- Experimental production/Quality Control Unit.

CRUDE DRUG DEVELOPMENT UNIT

Spaces include -

- Crude drug museum
- Herbarium
- Analytical laboratory
- Research laboratories

Activities include -

- liaise with traditional healers and herbalists for the purpose of research and development of their crude drug.

- to liaise with herbalists for the purpose of research and development of Nigeria's medicinal plants.

PROCESS DEPARTMENT:

Spaces include:

- Dry and cold storage for raw materials or crude drug.
- Drying and granulating space.
- Medicinal extraction space.
- Laboratory for preliminary analysis of extracts.

Activities include:

- To prepare the various raw materials into form that research can be performed on them.
- To collect basic information on both physical and chemical characteristics of potential drug substance.

QUALITY CONTROL UNIT

(i) CHEMICAL DEPARTMENT

Spaces includes:

- Storage space for specimen
- Analytical laboratory
- Instrument and preparations rooms
- Research laboratories

Activities include:

- To determine the chemical constituents of the various medicinal products derived from plants.
- To isolate such chemical compounds and chemical structures.

(ii) PHARMACOLOGY/TOXICOLOGY DEPARTMENT

Spaces include

- Specimen store
- Animal quarters
- Research laboratories

Activities includes:

- To evaluate the safety and efficacy of potential drugs. These include pharmaco-dynamic studies, acute, subacute and chronic toxicity studies in various animal species.

(iii) MICROBIOLOGY DEPARTMENT

Spaces include:

- Store for specimen
- General laboratory
- Research laboratories
- Sterile production laboratory
- Media store and preparation
- Incubator

- Cold room
- Cultures

Activities include:

- To determine the effect of microscopic organisms on potential drug.

Experimental Production Unit:

It consists of two major area quality and drug formulation area.

Quality Control:

- Spaces required include quality control laboratory and office spaces for staff.

Activities includes:

- To follow the huge file of instructions from the researcher in various departments in the formulation of drugs.
- To plan and achieve the required quality.
- To correct any quality short-comings
- To provide long term quality control and planning.

Drug Formulation Area:

- mixing room
- coating space
- tableting space
- filling and packing space
- store for finished products

Activities include:

- To manufacture product right from first time by following various quality control measure from raw material inputs to when end product is stored in appropriate condition.

6.3 Schedule of Accommodation

Table 6.1 Main Entrance

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Entrance Hall	1	120	120
Receptionist	1	20	20
Exhibition space	1	60	60

Administration

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Director of Centre	1	30	30
Secretary to Director	1	15	15
Board Room	1	60	60
Deputy Director (Admin)	1	25	25
Secretary	1	15	15
Deputy Director (Research)	2	25	25
Secretary	1	15	15
Secretary to Centre	1	25	25
Secretary	1	15	15
General Office	1	45	45
Administrative Officer	1	20	20
Staff Records (Personnel)	1	25	25
Record Officer	1	20	20
Typist	1	45	45
Common Room	1	40	40
Toilets	1	45	45
Total			510

Finance Department

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Chief Accountant	1	25	25
Accountant	1	20	20
General Accounts	1	45	45
Purchasing Office	1	30	30
Purchasing Officer	1	20	20
Store	1	40	40
Total			180

Information Services Unit

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Information Office	1	30	30
Information Officer	1	20	20
P.R.O.	1	15	15
Editing Office	1	20	10
Photocopy Room	1	20	20
Seminar Room	1	20	20
Seminar Room	1		
Auditorium	1	400	400
Toilets		25	25
Total			530

Computer Section

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
General Office	1	30	30
Head of Section	1	20	20
Computer Room	1	72	72
Data Bank	1	60	60
Data Controller	1	20	20
Computer Analyst	4	15	60
Total			262

Library Section

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Librarian	1	25	25
Journal Section	1	150	150
Reading Area	1	120	120
Audio-Visual Unit	1	80	80
Carrel reading	9	5	45
Store	1	60	60
Toilets	1	20	20
Total			500

Publication Unit

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Publication General Office	1	25	75
Workers changing Room	1	30	30
Head Publication Unit	1	20	20
Raw Material Store	1	50	50
Printing Room	1	60	60
Dark room	1	15	15
Binding Section	1	75	75
Common Room	1	40	40
Total			315

Canteen

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Food preparation	1	60	60
Store	1	20	20
Servery/wash up	1	36	36
Dinning	1	120	120
Total			236

RESEARCH UNIT

Crude Drug Development Unit

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Crude drug museum	1	90	90
Museum prep.	1	30	30
Store	1	45	45
Seminar Room/Inference	1	90	90
Traditional Consultant	2	45	90
General Analysis Laboratory	1	90	90
Instrument Room	1	45	45
General Office	1	30	30
Head of Unit	1	15	15
Secretary	1	9	9
Cold Room	1	22.5	22.5
Specimen Store	1	22.5	22.5
Ultra-violet Infrared lab.	1	45	45
Research laboratories	4	45	180
Balance Room	1	24	24
Centrifuge Room	1	24	24
Total			852

Phytochemistry Department

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Raw material store	1	100	100
Process laboratory	1	150	150
Analytical Instrument Room	1	45	45
Changing Room	1	40	40
Total			335

QUALITY CONTROL UNIT

Chemical Department

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Chemical store	1	120	120
General laboratory	1	90	90
Balance room	3	22.5	67.5
Head of Unit	1	22.5	22.5
Secretary	1	9	9
Research laboratory	2	45	45
Special room	1	45	45
Office cubicle	3	18	54
Mechanical room	1	45	45
Total			543

Pharmacology/Toxicology Department

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Head of Department	1	20	20
General Pharmacology lab.	1	90	90
Animal testing room	1	40	40
Balance room	1	22.5	22.5
Special room (autoclave)	1	22.5	22.5
Research laboratory	2	45	90
Office cubicle	2	18	36
Total			231

Microbiology Department

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Head of Department	1	20	20
Secretary	1	9	9
H.O.D. Lab.	1	22.5	22.5
Common Room/Seminar	1	45	45
General Microbiology Lab.	1	90	90
Balance Room	1	22.5	22.5
Office cubicles	1	18	18
Research laboratory	1	45	45
Cold Room	1	22.5	22.5
Media kitchen	1	45	45
Media store	1	22.5	22.5
Changing/prep. room	1	30	30
Sterility testing	1	18	18
Sterile prod. lab.	1	120	120
Toilets	-	-	-
Total			530

Experimental Production Department

Space	Number of Units	Floor Area of each (M^2)	Total Floor area (M^2)
Raw material store	1	90	90
Granulating room	1	45	45
Mixing room	1	45	45
Quality control lab.	1	45	45
Tableting room	1	45	45
Finished tablet store	1	45	45
Bottle washing	1	72	72
Liquid drug prep.	1	30	30
Filling and packing	1	45	45
Storage	1	90	90
Toilets	1		20
Total			572

Animal Quarters

Space	Number of Units	Floor Area in each (M^2)	Total Floor area (M^2)
Animal receiving	1	24	25
Cageslating	4	22.5	90
Animal washing	1	45	45
Total			160

Herbarium

Space	Number of Units	Floor Area in each (M^2)	Total Floor area (M^2)
Herbarium Officer	1	20	20
Record/Documentation Room	1	20	20
Herbarium	1	90	90
Total			130

6.4 Site Planning Studies (Summary)

The main problem when considering and planning a master plan for a research centre is to provide effectively for growth. The growth might not be easily predictable, therefore, the principal objective in the planning is to provide for expansion to take place without disruption of built up areas. Another main important consideration is the need for maintaining good circulation between laboratory and other services.

Approaches to planning of research centre based on the above guidelines are discussed below:

(a) Central Focus

The planning is composed of buildings of common uses located in the central focal area with regards to other buildings. Such buildings include library, information services, and computer unit. Thus arrangement allows for easy accessibility from all departments. This combines the advantage of both multi-foci and compact planning.

(b) Multi-Foci

This involves providing for multiple foci from the start of the research centre. This type of planning is often used in campus planning. It is well suited to an organization of essentially non-related functions. Advantages are the ability to separate operations, easy expansion of units and pleasant atmosphere.

Disadvantages lie in increased cost of both structure and service distribution and difficulties of communication.

(c) Compact Design

This is an extreme situation that involves having all the laboratories, offices, and central utilities in one building. This type of building is best suited for a restricted research programme. Advantages are building economy and easy internal rearrangement. It also has the advantage of saving land costs and services. Disadvantages lie in problems of isolating operations, limited expansion, disruption of work when expansion is required and difficulty of adapting to an irregular site.

(d) Linear Central

This provides for central facilities in linear kind of form, placing library, stores, canteen, etc., along a street running down the centre of the site. Such a plan has the advantage of open ended and can be easily extended as the need arises.

6.5 Site Planning Principles

(a) Optimum expansion possibilities with little or no disruption to initial proposal.

(b) Provision of vehicular traffic free areas, that is a pedestrian intra-centre traffic devoid of cross vehicular traffic. This will help in maintaining

acceptable noise level required for effective research work particularly the library and research laboratories.

(c) Optimum orientation of buildings in order to reduce solar control problems. Longer sides of building have been northernly or southernly oriented where design permits.

(d) The research areas have been placed inner most where problems of noise due to heavy traffic is absent.

(e) Zoning of like facilities together, section that are prone to growth are grouped together and those that are not are grouped together.

6.6 Conceptual Development

"The development of organisational patterns for design program begins with the observation of the characteristic patterns of the users. This reveals a hierarchy in frequency of the use".[1]

The physical design is generally the result of a combination of three concepts:

(i) The characteristics of the construction site; its shape, the surrounding environment, accessibility, etc., lead to a specific design form.

(ii) The use of the functions of the structure as form generators.

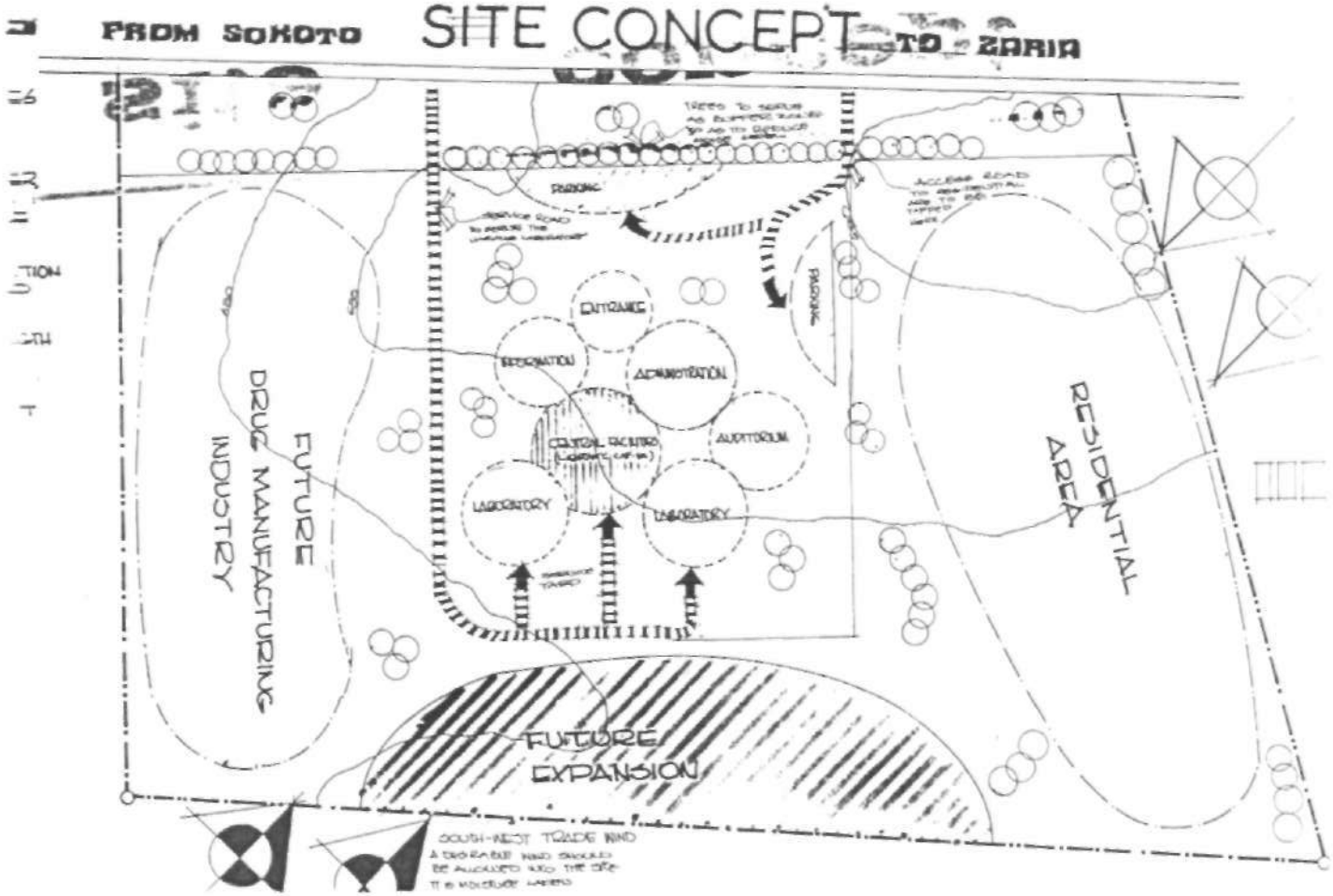
(iii) Accommodating the program in an arbitarily pre-determined spatial form.

It is obvious that the best organisational solution is a combinational or product of all the concepts. However, majority of architects employ their own distinct alphabet of archetypal forms within which they have developed their spatial skill or visualization and design. Some of these model include the star, the ring, and the grid model. Each of these basic model favours spatial form of organisation that is flexible or rigid, open ended or finite, centralised or divergent, and so on.

6.7 Design Concept and Design Character

The concept of the design occur from one of the basic conceptual form (radia) of design discussed above. However, other factors considered include site constraints which include microclimate, shape of the site, expansion possibilities and also the way the research centre functions.

The radial concept used which is often called star due to its shape is favourable if all functions and activities have their origin or destination in a central core. The information services unit is used as the central core; since it has a centralised functions.


FROM SOKOTO
TO ZARIA
ENTRANCE
PARKING
ADMINISTRATION
AUDITORIUM
LABORATORY
LABORATORY
FUTURE DRUG MANUFACTURING INDUSTRY
RESIDENTIAL AREA
FUTURE EXPANSION

Shape of rooms are mainly rectangular in order to achieve flexibility and adaptability.

Buildings are groups to form courtyards and corridors are single loaded to ensure adequate cross-ventilation.

6.8 Spatial Arrangement of Functions

In general, a complex of this nature must be functional, compact in space and design in relation to capital and operating costs. There must be satisfactory working conditions, safe equipment and provision for the highest sanitary standards. Internal communications must promote and reflect inter-relationship of work. Dust must also be reduced to the bearest minimum.

Administrative Unit: The administrative block is located adjacent to the main entrance. The main entrances have a small exhibition space. The space above the main entrance - that is first floor level is used as the executive suites which has the director's office and the board room. Administrative activities which have public bearing are located on the ground floor.

For comfort and good cross-ventilation, courtyard have been provided which shall be drained from under the building. Circulation areas are located around the courtyards, and major public utilities are also located here.

The auditorium which is meant mainly to serve the public is located at visible point as one approaches the centre. It is reached directly from both the parking lots and the entrance lobby.

The information services unit is located between the laboratory and the entrace area, giving it a centralised location. The information services unit feeds the public with research findings and it is itself fed with information on research results emanating from the research unit. The computer units, research library and seminar room are all located here because of their interrelationship.

Research Laboratory: The research section is divided into two main units. The crude drug development unit and modern drug research unit. This is done because of the absolute need to separate the two activities. In between the two units are located functions which are shared by both units; these include workers facilities, animal quarters, herbarium and herbal garden.

The crude drug museum is located at the laboratory area because of the absolute need to keep most of the crude drugs away from the public. The crude drug development unit is located at a place which can be easily accessible to the public zone. This is due to the occasional need to bring traditional healers to the laboratory. The relationship however is not strong.

The research laboratories is the area of highest refinement, that is, where the majority of thinking for the centre is done. It is therefore located on the top level which in this design is the first floor. The ground floor area are used mainly for drug processing and storage purposes.

The layout in the research laboratories with an office enclosure (cubicle) in each laboratory is done because of the absolute need for the scientist to be as close as possible to his experiments. It is possible, of course, to remove the office space from the laboratories to a separate wing, but this was rejected because of distance and lack of privacy.

Laboratory services are distributed from the service room through the suspended ceilings along the corridor to individual laboratories. Ducting has been used in the chemical laboratories because of excessive fumes which has to be passed out. Laboratory benches are provided with plugmold having 120-volt AC receptacles, spaced 450mm on centres and 208-volt receptacles limited to two to each 6-metre laboratory module.

6.9 Structural System

A simple structural system of reinforced concrete was adopted. A grid modules of 6x6 are employed in the administrative block, while 6x10 was used in the laboratory area. The columns are 6m from centre to centre.

The section reveals columns at an angle outwards, tapering from bottom to the top hence giving a near pyramid look to the building. Storage space was provided along the corridor to provide for better utilisation of the unusual 2.4m width of the corridor.

Each columns carries a beam thus reducing the depth of beam required to span the unusual 10m grid span. A suspended ceiling was used to create enough space between the ceiling and the floor slab or roof for services and other accessories.

The overall result is a rectilinear framed building in which the interior partitions can be manipulated at will without any structural adjustments. This satisfies one of the most important requirement of research laboratories design.

Other components of the research centre apart from laboratories, administrative block, auditorium are of reinforced concrete construction with load bearing walls and reinforced concrete roof slab. The concrete decking is well insulated and graded, so as to provide the required 8-hour time lag for heat penetration recommended for the prevalent climate. The roofing system adopted in the laboratory and administrative block is the steel roof truss with Z-purlins.

6.10 Landscape

Landscaping is used to provide privacy, define circulation and recreation spaces, provide shade, reduce noise, provide pleasant visual experiences, reduce glare and movement of dust particles, filter harmattan haze, induce humidity and define certain circulation routes. The courtyard employed a great opportunity whereby landscape elements can be used to achieve most of the enumerated functions above.

Shade trees are provided at the parking areas and at building facades to limit sun exposure and glare and in the latter reduces surface dust and erosion, while small ornamental trees shade provide visual beauty and serve as intermediate level wind breaks. Landscaped earth berm walls, planted with flowering vines and bushes, provide vistas of colour and foliage, reduce ground dust from storms, give relieve to the flat terrain and serve as hard edges visually and physically separating public from private areas.

6.11 Special Requirement-Services

Services form an essential part in the planning and design of laboratories. In planning the module, mechanical and electrical considerations are far more critical than architectural elements. Mechanical and electrical services are far less flexible. They are costly to redesign or alter. In addition, human consideration

also constitute a major consideration, that is safety factor. It is therefore necessary to consider the technical and safety requirement.

Plumbing - To prove greater flexibility, all laboratories should have air vacuum, water, gas and electrical services at all work areas.

Fixtures must be selected with care to suit the particular fun tion they serve. There are standardised type, but care must be exercised in selection to ensure materials that will withstand rigorous usage.

Piping system - Four basic sondierations are important in piping systems design. For laboratory areas:

1. Location of systems to provide easy accessibility.
2. Provision of sufficient space to accommodate systems without crowding.
3. Sizing and arrangements of systems to facilitate expansion and modification as required and
4. Quality of materials used in fabrication of the systems.

Normally systems are concealed in wall chases, both vertical and horizontal. Vertical systems should have shafts of sufficient size to permit entrance of services personnel and the use of tools within and horizontal connections may be in horizontal chases with removable panels or overhead above the ceiling.

Overhead systems may be exposed or concealed above a suspended ceiling. Exposed systems will require a lot of cleaning as they will accumulate dust and so are not quite advisable in the Sudan savannah climate. Concealed systems have the disadvantage of having to remove ceiling panels for servicing.

Piping systems should be sized to serve not less than twice the initial capacity, as proper laboratory design assumes that a number of physical changes in layout and equipment will occur periodically. Materials used should be with the best quality available to avoid costly repairs and replacements that may result from use of inferior goods.

Drainage systems - In general, systems used and materials will conform to standards for laboratory buildings. However, systems serving animal quarters and laboratories are subjected to harsh use. Types

of liquid waste to be disposed from each laboratory should be the basis for the selection of piping material and design of systems. To ensure permanent trouble-free drainage systems, acid-resisting piping materials should be used. Where the volume of such waste is large, separate acid waste systems may be provided.

Where extensive, use of high-level radioisotopes is indicated, a separate drainage system is required, discharging to a stainless steel tank, stainless steel is recommended as drainage material because it can be made leak tight and its smooth interior allows easy flushing.

Water - An analysis showing the characteristics of the local water supply should form the basis for the selection of piping materials for hot and cold water systems. This analysis will also indicate whether treatment is required and the type.

Copper piping is recommended for water distribution systems with galvanised wrought iron for mains over 125mm in size. Water systems in laboratory areas are in constant danger of contamination from toxic elements and can endanger the whole portable water supply. Colour loding and lettering of piping systems is therefore necessary.

Sprinkler system - A sprinkler system in addition to the standard standpipe system is recommended for chemical stores and other storage rooms housing volatile materials and laboratories in which such materials are used.

Gaslines - should be generally sized to provide for expansion of services and to maintain constant pressure outlets. A main emergency shut-off valve

controlling the gas supply to each laboratory should be available at an accessible location, preferably outside the laboratory. Black steel piping is appropriate for gaslines.

Compressed air and vacuum systems - Copper tubing is usually used although galvanised steel and threaded malleable iron fittings may be used. They too should be generally provided to cater for expansion. Discharge from vacuum pumps should be to the outside, and the pumps and air compressors should be located on lower floors and isolated from the building structure because of vibrations that occur during their operation. This vibration may seriously affect microbalances, electron microscopes and other precision equipment.

Oxygen systems - Copper piping is recommended for these systems. An emergency shut-off valve is equipped, accessible and preferably on the outside. For the laboratory, care must be exercised in locating the outdoor bulk supply because of fire hazards.

6.12 Maintenance

The concentration of laboratories and other serviced areas towards the southern part of the site should lead to a well integrated engineering department. The engineering department is so planned to serve both the research centre and the future factory envisaged for the centre. Water hydrants have been provided at

strategic locations on the site for use in case of fire accidents. The road network has also been planned to facilitate easy access to the laboratories and other serviced area where a great maintenance job is required.

6.13 **Materials and Finishes**

Laboratories, preparation rooms, rooms for special purposes, services rooms and the like should have floor finishes which are smooth and acid resistant. Quarry tiles with cove base are recommended. Good results can be obtained from the use of such resilient flooring as vinyl-asbestos and rubber base.

Wall finishes may be plaster, glazed tile, or the more economic mansory block. For partitions between research laboratories, cement asbestos, dry wall, and prefabricated movable partitions may be used, most especially steel prefabricated movable partitions for their resilient qualities. Mansory block is also a satisfactory material.

In sterilising and glassware washing area in Microbiology Department, quarry tile or terrazo floor is desirable. Walls and ceiling should be moisture resistant. Portland cement plaster and water resistant, high-gloss paint is acceptable. Glazed tile with sanitary covery is however better.

Cold rooms should have ceramic or quarry tile floors, cove base, and cement mortar walls and ceilings. Where prefabricated colds rooms are installed, prefinished surfaces are usually stainless steel or porcelain enamel.

Corridors should have resilient flooring. Walls may be of mansory block or other durable finish. Corridor ceilings are made removable for access to pipe and ducts. Removable acoustic tile ceiling boards are recommended.

Chapter 7

CONCLUSION

The proposed centre when finally realized has the following to offer:

- Promotion of science and technology in Nigeria especially in the medical field.
- It will create a forum for convergence and distribution of scientific and technological information on Pharmacy.
- Public awareness on the use of herbal medicine will be improved.
- It will aid quick integration of traditional medicine into the official health care scheme.
- Above all, it will reduce drastically the huge foreign exchange earnings of the nation expended on drug importation.

Inclusion of a training unit in the centre will, with time, save the nation's manpower needs in this field. It is recommended that field stations should be established in the different vegetational zone of the country, because of the different herbs which abound in various part of the country.

Finance

The research centre will only need initial capital for erection and installations of equipments, subsequent maintenance cost will be paid by revenue collected through consultancy services the centre is expected to perform for pharmaceutical industries and other interested organisations. If properly manage, it could pay back its erection cost in the long run. Initial erection cost could be partly financed by the government while the other part is provided by business groups, philantropists, contributions from various professional organisations and by the launching of appeal fund all over the country.

The Federal Government should take pharmaceutical research seriously and give it the necessary financial support. It is hoped that this thesis report would apart from providing complementary data on architecture of research centre, would also contribute to making Nigeria self-sufficient in its drug needs.

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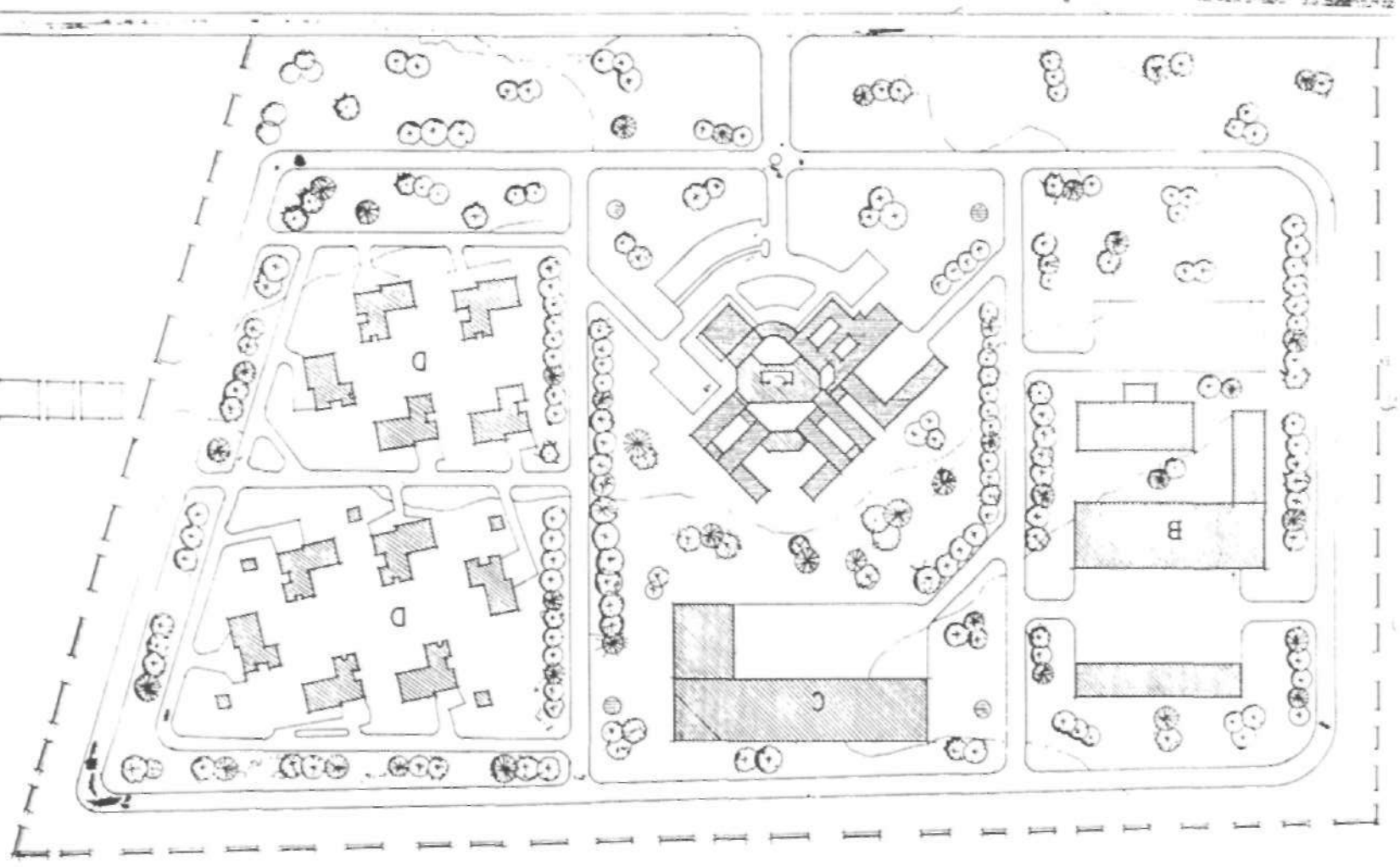
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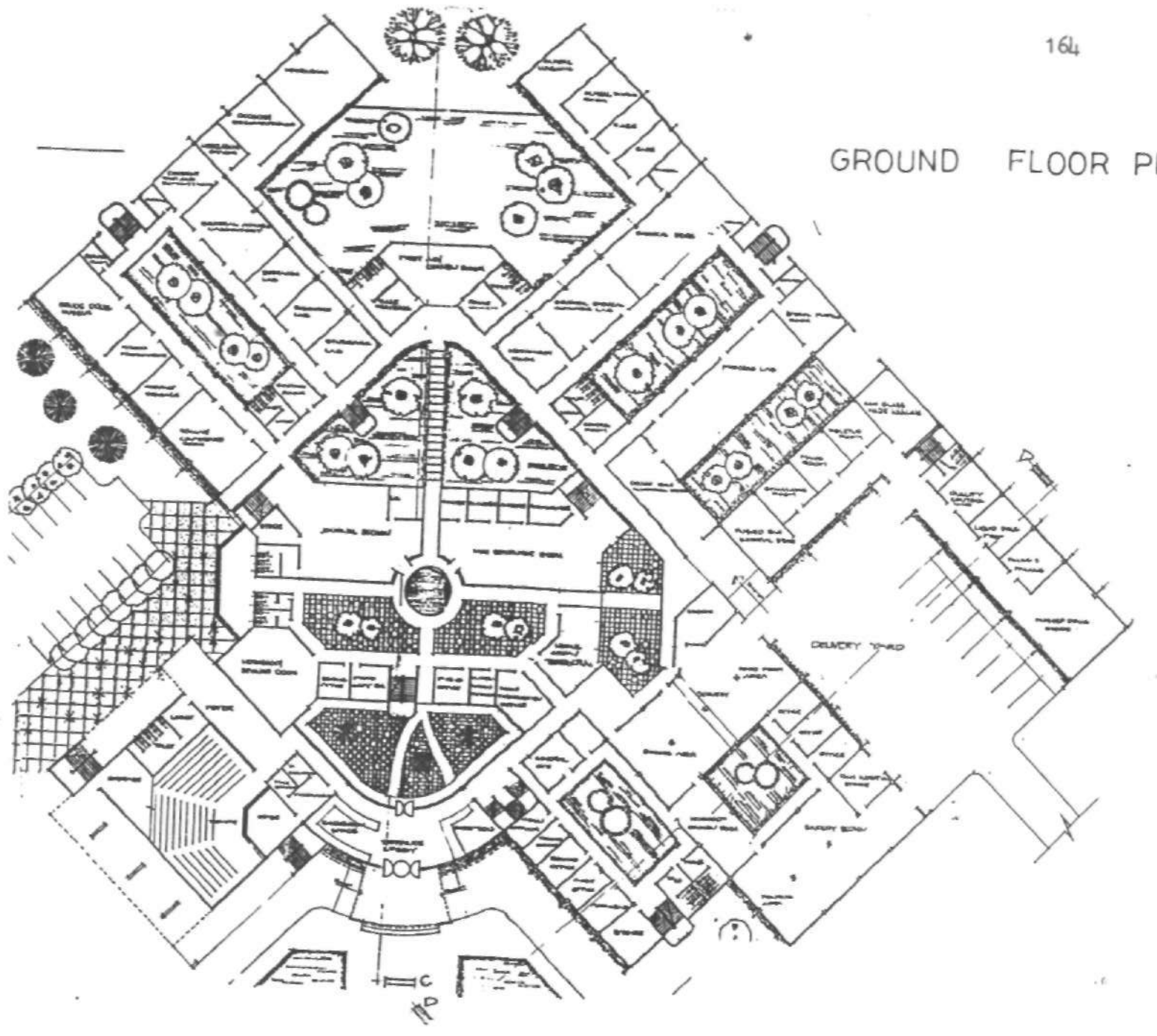
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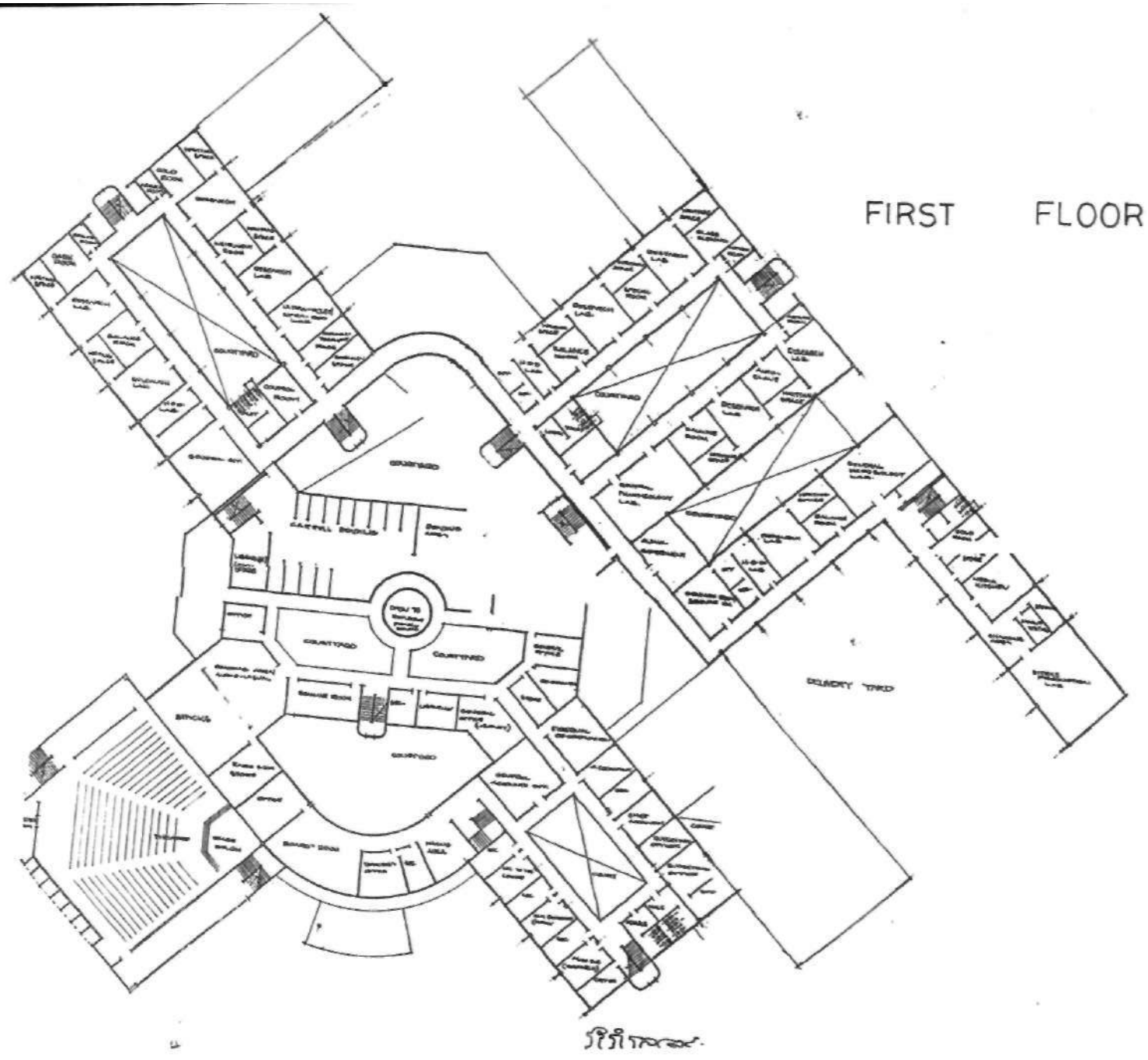
SITE SCHEME

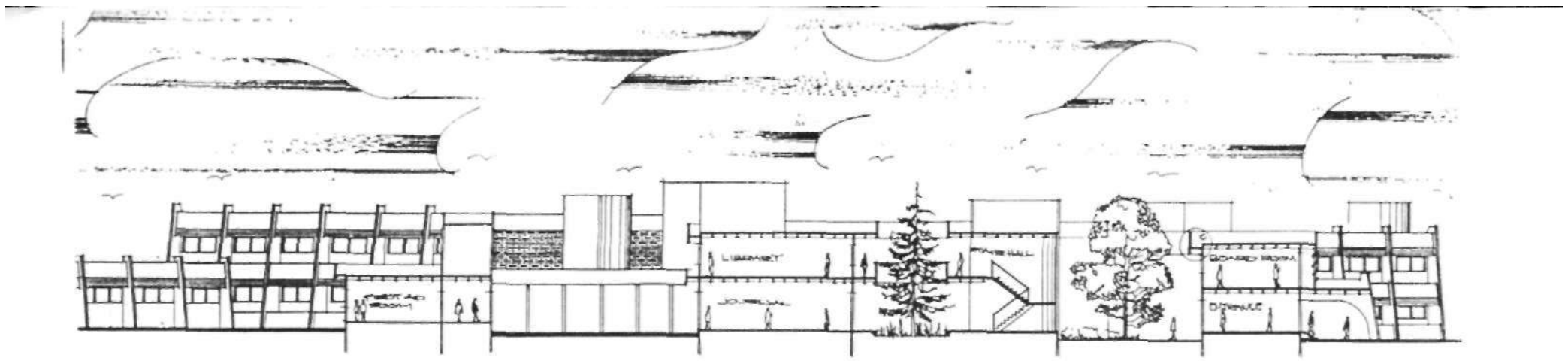


GROUND FLOOR PLAN

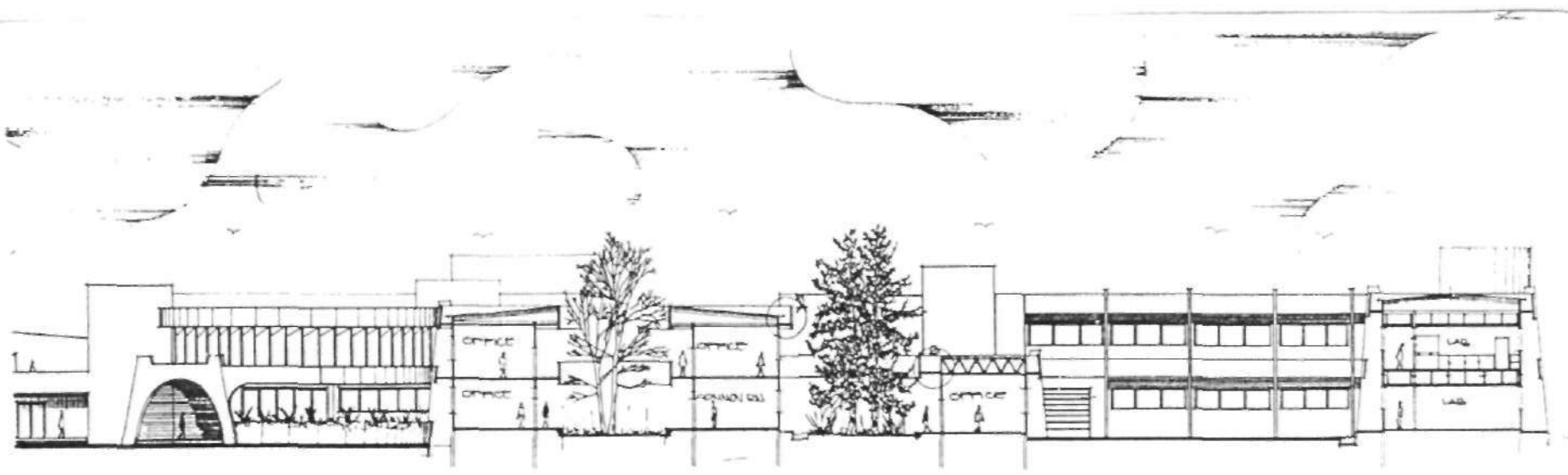


FIRST FLOOR

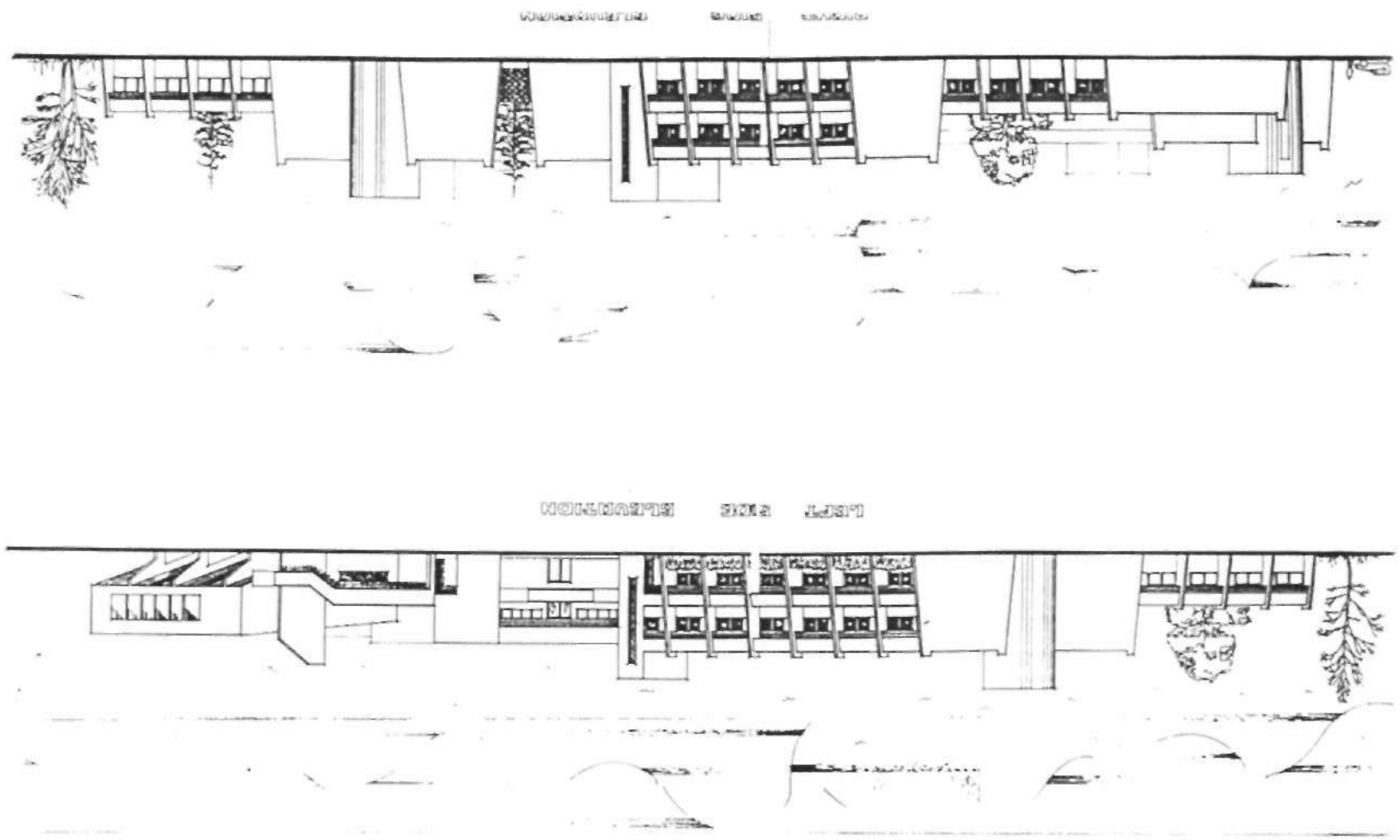




SECTION C-C



SECTION D-D





INTERIOR OF RESEARCH LABORATORIES