D E C L A R A T I O N

This Thesis is my original work and has not been presented for a degree in any other University.

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Master of Architecture

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ABSTRACT

The character of a space is defined by its function and the relationship with the specific environment. Laboratory accommodation may broadly be defined either as specialised, in the sense that it is generated by a particular piece of furniture or equipment, or as General in the sense that it is suitable for a wide variety of disciplines as well as widely varying techniques within each discipline.

The University has proposed to put up the following facilities at Chiromo campus:-

2 General teaching laboratories with their Ancillaries,
2 Lecture theatres, Post-graduate laboratory,
Physiology laboratory, offices-cum-laboratories,
Electron microscope room, Radio Isotope laboratory and
Photo laboratory each with the necessary ancillaries.
The facilities are to house the biological sciences.

The proposal is related to the existing Zoology/Botany Block through a covered walkway. The overall relationship with other buildings is achieved by pedestrian malls and courtyards that flow into each other. The project shows some uniqueness compared to the existing structures because of the way it is serviced and the system upon which it is evolved. It is able to grow by repeating itself linearly. This concept allows for a new unit to come up without affecting the existing units. The only modification to the system is when special facilities electron microscope are required.

The site bounded by Gecaga Institute, the Zoology Botany block and the I.C.I.P.E. buildings, steeply slopes towards the river. The rock surface is very near the top soil. The site is reached by two distinct routes; by road from the river side drive and by pedestrians from the halls through the University sportsground.

Servicing forms the skeleton of the laboratory. It has determined the structure by using double columns. Provisions are made for heavier servicing in the event of expansion. Because of servicing, maintenance and adaptability, services should be kept away from the structure. The basic services required are:-

Water,
Electricity,
Compressed air,
Gas,
Telephone and
Waste Water disposal.

I have provided removable panels covering the services so that they can be removed and repairs made to the piping.

The internal layout is such that the user can make changes with little qualified manpower. In the large teaching laboratory, it is done by use of sliding pannels. The division walls are not structural and has no installation in them. The integration of components is kept to a minimum. Surface installation for electricity is recommended so that changes are made without complications.

Cost is usually a major problem in the building industry. Because of the investiment that goes in the laboratories, we do not think much about the adaptability of the spaces. In the case of adaptability the services will remain, but drawers and storage units are stored elsewhere and the room used for other purposes. Flexibility therefore should be given attention in the design of educational buildings all the time.

ACKNOWLEDGEMENTS

I wish to express my very sincere thanks for cooperation and guidance on my project to the following :-

Messrs : Bruce Creager, Jim Archer and Mehraz Ehsani as class tutors; and particularly Mr. Bruce Creager for the help in resolving my layout in the letter stages af the project.

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To my collegues and students of Architecture for constant support.

To Diana Chibeu for typing my thesis.

BINDING

BOOKS

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INTRODUCTION

Laboratories are becoming the most important building types of our time. This is particularly so in the developing nations, where every step taken in the form of development should be tested, so that their ambitions are not crippled by the failures. We notice that trial and error in the developing nations has been a necessary risk, but with the present advancement in science and Technology, and world inflation, research and experimentation have become so important that, it is necessary to have buildings designed to be able to accommodate any situations that could arise.

Already, there are efforts, particularly in the Ministry of Works, to standardise building elements and functional areas. The University is acknowlegable institution and very sensitive to modern educational building facility concepts, and therefore strong efforts should be made to evolve a close interaction among all the faculties so that the extensions that come up should be applicable to most of them; with few modifications to take up specialised areas.

The main task for the writer, therefore, is to evolve a solution that will meet the requirements of the biological sciences and other needs that could arise. Because of the fast increase in the number of students and the somewhat unpredictable developments in teaching methods, the spaces that are designed in the project should be able to accommodate these developments. Once a Vice-Chancellor, Mr. Haslegrave made the following remarks on the University plans; "On the building side, there are many who wish to erect impressive, palatial buildings - to build for Posterity. There are many who press for highly specialised faculties being built permanently into fabric so making buildings unsuitable for other purposes without a large expenditure of effort and money."

In my proposal, I have tried to dissolve faculty patterns in order to avoid an early specialisation. The school of studies is hence established with a broader basic education than in the traditional sense. It is a continuous building structure for teaching and research which is characterised by the fact that the building is not sub-divided according to faculty, but according to functions.

I started the project by attending meetings between the Building sub-committee and the project Architect. From the meetings I was able to learn the general policies and objectives of the University. This was to clarify the type and nature of buildings expected both in Architectural concept and cost of the buildings. This I gathered from the reactions of the members of the sub-committee to the Architects' proposal.

Finally, and most important, a survey of the existing laboratories was necessary to obtain an inventory of facities essential for the future projections of the University. The information I gathered was by the use of set questionnaire and formal interviews from the clients and users who included staff and students. From the information gathered, I set out the scope of the project.

PRELIMINARY OUTLINE

SCOPE

The University building sub-committee acting as the client produced the schedule of Accommodation for the three Departments and handed it to the project Architect. I also got copies of the Accommodation. After a series of meetings, involving the client, the project Architect and myself, an agreed upon schedule was worked out on the basis of shared facilities, since the University could not afford all the facilities requested by each Department. This schedule with the Areas is given in the Appendix I.

The facilities that were urgently needed in Biological Sciences* were :-

1) Lecture theatres
2) Teaching Laboratories (General, Physiology, Radio Isotope) and their ancillaries, e.g. Balance rooms, Instrument rooms, Preparation rooms etc
3) Seminar rooms,
4) Dark room and Electron Microscope
5) Administration suite
6) Staff Accommodation
7) Post-graduate offices, and laboratory.

These are the facilities upon which I have based my Design.

AREA OF STUDY:

Before we go further in the details of the design, certain terms ought to be defined, or made clear:-

LABORATORY: - is an enclosed space equiped with the necessary services conveniently positioned for the users needs. There are three classifications to the laboratory according to :-

a) Scale - Bench Scale, Pilot Scale, factory scale
b) Activity - Routine, Research, Teaching
c) Discipline and Technique - Chemistry, Biology, Physics.

<u>BIOLOGICAL SCIENCES</u> - The Departments which are covered in this title are; Botany, Entomology and Zoology

The main aim in this project is to define those aspects of the disciplines which affect the performance of the building. These include:-

1) Working Area - to adopt a method of assessing space requirements.

2) Services : - Establish standards of provision and patterns of the services.

3) Equipment: - The equipment to be used in the building could affect its design.

4) Finishes: - The performance of the building or the particular space is dependent upon the finish. The finishes should be able to withstand things like stains, chemical - reactions, water and easily cleaned when contaminated.

<u>APPROACH</u>:

In trying to work out the details of the design where very precise information on several important aspects of the project is required, I had to define the limits of my investigation. The terms of reference for my project was confined to teaching and student research laboratories. The survey was performed on limited teaching laboratories at the following places:-

Egerton College - Njoro, Kenya Science Teachers' College, and of course the University of Nairobi, at Kabete and Chiromo campuses.

The method I use in gathering the necessary information from the existing laboratories was :-

a) Use of Questionnaire, a sample of which is in appendix III.

b) Informal Interviews with the users and laboratory technitians.

c) Personal observation.

When the results of the study are taken separately, each, has a contribution to one or other aspect of the problem. When put together, they suggest an approach to a dopt in the design of laboratories with certain predominant parameters, depending on whether it is highly specialised in the sense that it is generated by a particular piece of equipment or particular Technique or General, i.e. suitable for a wide variety of disciplines as well as widely varying techniques within each discipline.

PLANNING OBJECTIVES

In designing the facilities requested by the University, I have got three main aims to achieve in the overall planning.

1) To allow for growth and change in the teaching and research technique.
2) To establish a basic planning grid which takes account of the Nuffield report on the "design of research laboratories", and the experience gained from general observation on research needs, teaching, offices, meeting rooms, electron microscope rooms etc.
3) To design a structural system capable of housing a rationalised services system.

DESIGN CONCEPT

In addition to planning for growth and change in research and teaching techniques, we have to consider the concepts behind teaching and research.

TEACHING

The Universities at present, particularly in the field of science have moved away from the standard demonstrations and a set of practicals, towards a more creative learning through self-experimentation and exploration (exampliefied by Nuffield Science Scheme).

This greater similarity in research and teaching makes a unified view of laboratory requirements practicable. This means allow more work space in the teaching laboratory.

RESEARCH

This field in most disciplines has been relegated to last place on budget priority list. Now it is understood that it could lead to savings that dwarf investiments. I therefore recommend establishment of research sections in all the disciplines. This is being given the necessary attention by providing every lecturer with a lab-cum-office. Then there is the continued increase in the research facilities for post-graduate students. This changing and growing quality of research work and teaching calls for both flexible and adaptable designs.

FLEXIBILITY

We apply flexibility to the performance of a space. It could mean working out a large number of possible functions to be accommodated in one space, so that they could interchange easily. In my case it mainly means knocking out partitions. This enables one to just get the right size of the room by moving by a small element. In this project you increase by 750 mm.

The writer has tried to develop a comprehensive system which will relate to the needs of various departments and disciplines. In addition, the system provides an architectural recognition of the increasing inter-displinary nature of much scientific research by provision of storage facilities.

The system has been worked out not as a monument, but as an instrument for carrying out and developing mull-form programmes that may change with time.

ADAPTABILITY

This term mainly refers to specific rooms. The room ought to be adaptable i.e. use it as an office, as a laboratory/office or research unit. This means that the furniture and services components are conveniently changed. This is achieved by use of movable storage cupboards and services that can easily be disconnected with minimum time and cost. The elements are independent of each other.


MAP A
CHIROMO
CAMPUS
CITY OF NAIROBI
0
5
10

LOCATION

The site for the project is located at Chiromo campus on the Northern side of Nairobi. See the location on the Nairobi map A. The land is the property of the University of Nairobi. The actual site is located on the Chiromo campus map B. It is bounded on the North by the Botany/Zoology block, on the West by the Gecaga Institute. On the South by the Mugonga Wai River and on the East by the I.C.I.P.E. plot.

TOPOGRAPHY

The site slopes 12.5% or 1.8 which is very steep. Reference is made to the contoured map and the relevant sections through the site attached to the report. The site also has a rock lying close to the surface.

ACCESS

Chiromo campus is served by two vehicular roads, all branching off from the River side drive. The first branching off the road from town centre leads to physical sciences and I.C.I.P.E. premises. The second branching passes through the library, Anatomy and leads to Botany/Zoology block. The access to the project is by this latter branch.

The site is also served by the pedestrian walk from the Halls of residence. This walk penetrates to all parts of the site and serves as a major link of facilities on the campus, and all the disciplines.

LAND USE

The proposed site at the moment is used for the following facilities :-

Animal houses, Seisomological station and Botanic gardens. The functions will be phased out overtime. Particularly the Seisomological station which initially presented constraints because it was not to be removed.

VEGETATION

Chiromo campus is heavily guarded by a forest of trees. With the new developments coming up, rapidly, most of the vegetation on and trees are being cut down. The proposed site has very few trees and that is why I have proposed planting new trees, this will match up with the landscaping.

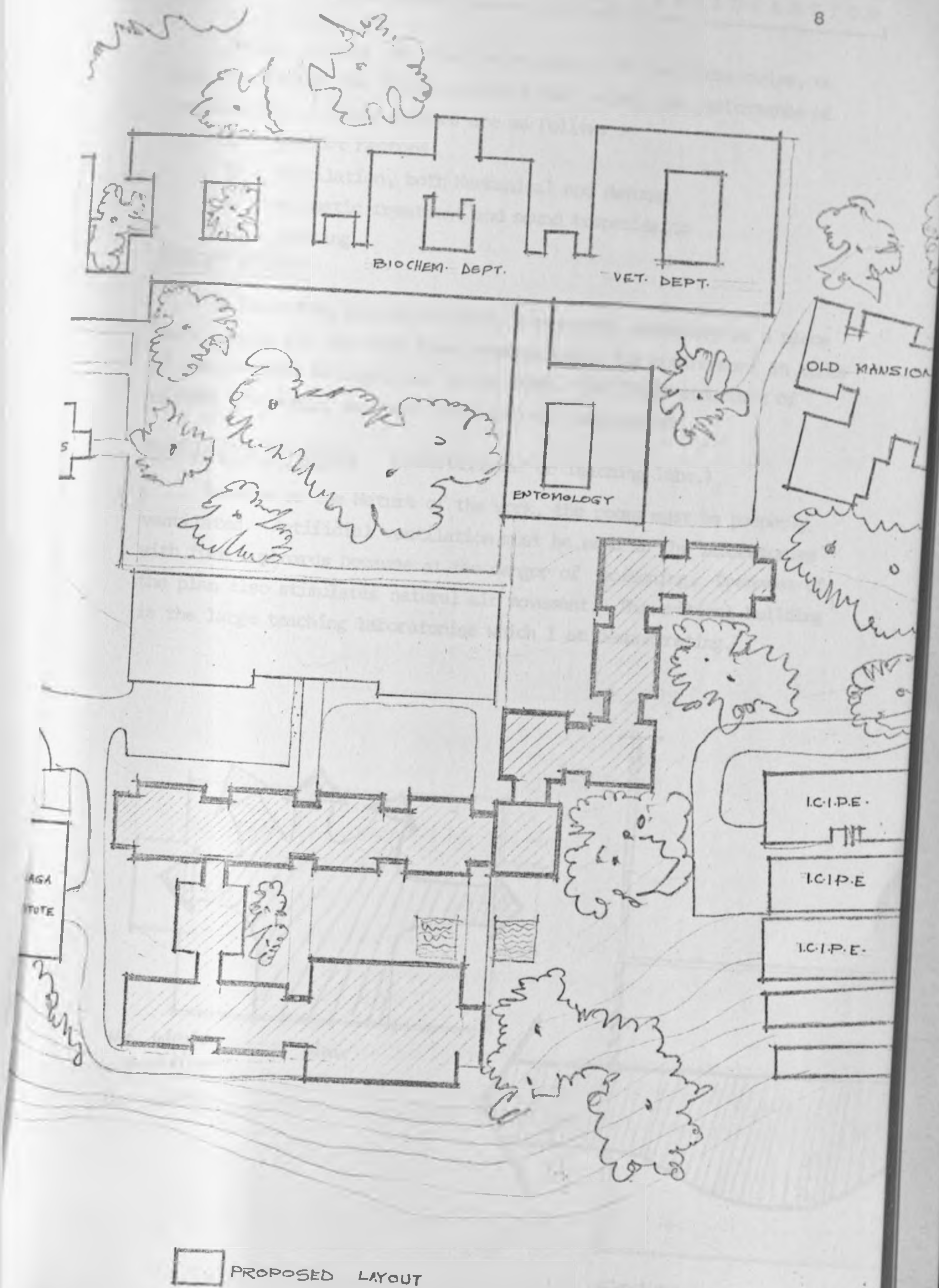
PHOTO 1: Part of Site as seen from the Zoology/Botany Building. I.C.I.P.E. new buildings seen in part on the left. Old I.C.I.P.E. seen in the background to be demolished.

PHOTO II: Another part with Gecaga Institute in the background on the right. Other structures to be demolished

PHOTO III: From the lower side of the Site looking towards Zoology/Botany Building.

PHOTO IV: Another part of the Site with the Seismological Station to be phased out. Gecaga Institute faintly seen in the background on the left.

MAP B


BIOCHEM. DEPT.
VET. DEPT.
OLD MANSION
ENTOMOLOGY
I.C.I.P.E.
I.C.I.P.E
I.C.I.P.E.
PROPOSED LAYOUT

DESIGN CRITERIA AND CONSIDERATION

Before we work out finally the design of the laboratories, we have to consider the design criteria that affect the performance of the building. These factors are as follows :-

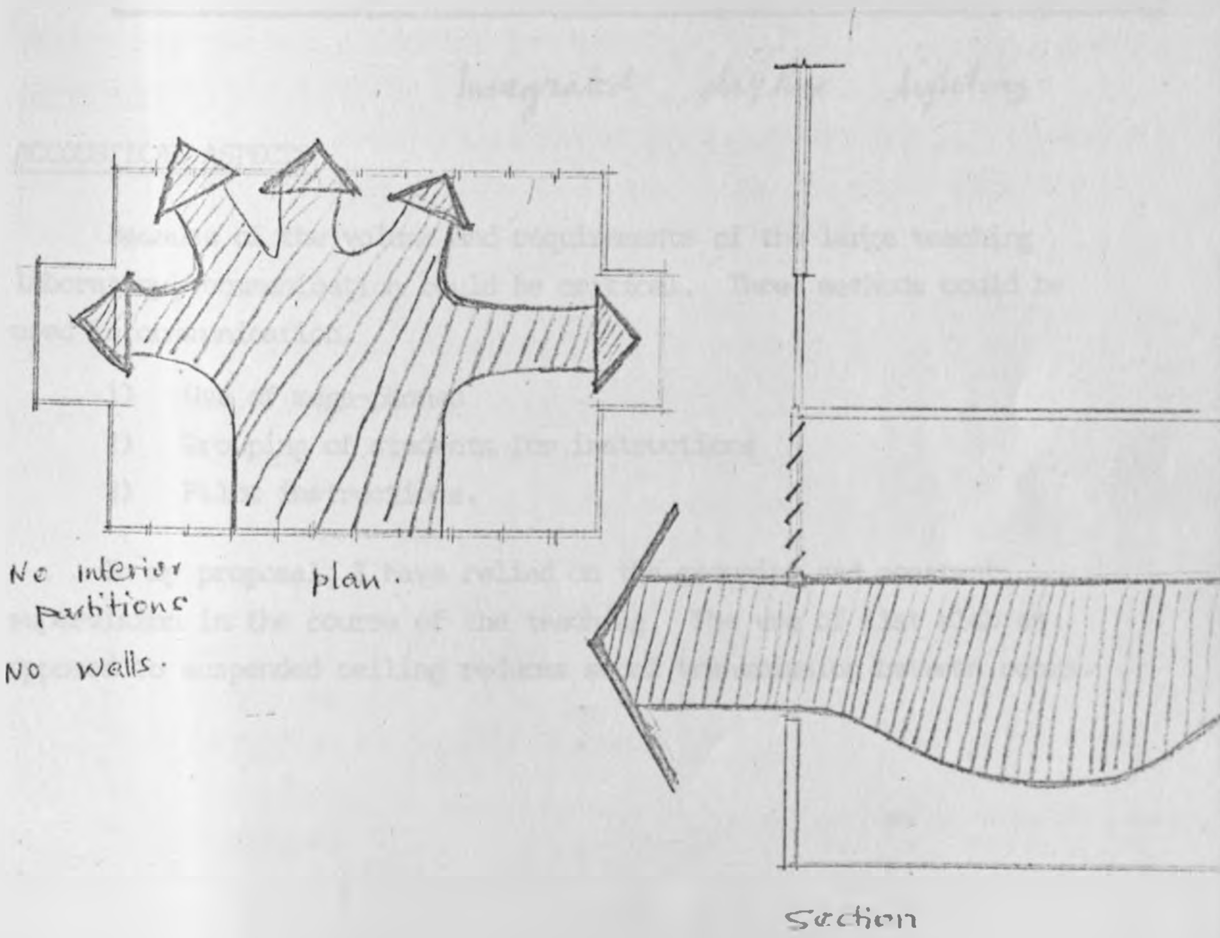
1) Comfort Factors
2) Ventilation, both Mechanical and Natural
3) Accoustic treatment and sound transmission
4) Lighting

COMFORT FACTORS

A laboratory and particularly a research laboratory is a place where people sit for many hours experimenting. the environment in terms of comfort must be conducive to the work. The heavy structure of columns also helps maintain constant room temperature.

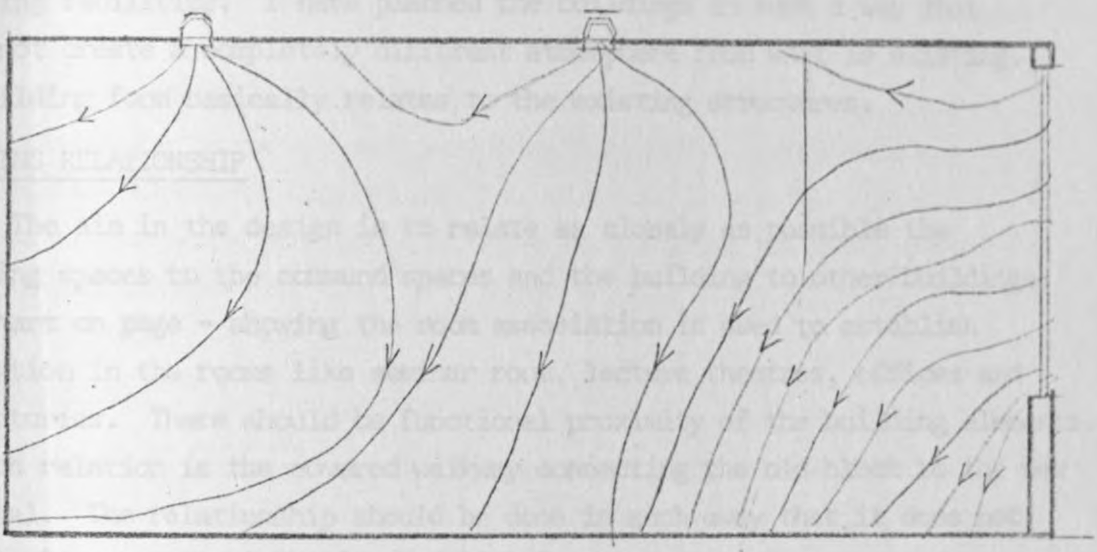
VENTILATION OF SPACES (LAB./Offices/ or Teaching labs.)

Because of the Nature of the work, the rooms must be properly ventilated. Artificial ventilation must be used in the laboratories with fume cupboards because at the danger of poisoning. Openness of the plan also stimulates natural air movement. The critical building is the large teaching laboratories which I am demonstrating.



LIGHTING OF LABORATORY AND OFFICE SPACES

While lighting of the laboratory is important, natural lighting is secondary in the laboratory buildings. Direct sun is also not wanted and so we must sun shade our laboratories. This done partly by the use of sun breakers and mainly by the orientation. Because of the nature of the work laboratories need a high daylight factor and of a reasonably constant value. We therefore have to supplement alot with artificial lighting. See demonstration. Maximum depth for natural light is 6.8 m.



Integrated daytime lighting.

ACCOUSTICAL ASPECTS

Because of the volume and requirements of the large teaching laboratory, communication could be critical. Three methods could be used in communication.

1) Use of mega-phones
2) Grouping of students for instructions
3) Pilot instructions.

In my proposal, I have relied on the grouping and constant supervision in the course of the teaching. The use of flat slab as opposed to suspended ceiling reduces sound transmission between rooms.

Any building or design that is proposed usually has certain determinants or goal inherent in it. For the Chiromo campus, I consider the following as the design determinants :-

1) Site Planning
2) Space and building relationship
3) Servicing
4) Structure
5) Building materials and methods.

SIDE PLANNING

The campus has permanent structures build on it and therefore the buildings that come up should create a workable relationship with the existing facilities. I have planned the buildings in such a way that I do not create a completely different atmosphere from what is existing. My Building form basically relates to the existing structures.

BUILDING RELATIONSHIP

The aim in the design is to relate as closely as possible the teaching spaces to the commund spaces and the building to other buildings. The Chart on page - showing the room association is used to establish a relation in the rooms like seminar room, lecture theatres, offices and laboratories. There should be functional proximity of the building elements. On such relation is the covered walkway connecting the old block to the new proposal. The relationship should be done in such away that it does not affect air movement visibility and lighting.

SERVICES

Services form a major skeleton of any laboratory design. The scale of provision of such piped services to the bench is a major issue and in most cases will determine the structure of the building.

According to the survey the author carried out the following services were found used permanently and to which he has paid attention.

1) Cold water supply
2) Drainage waste - (a) Normal dirty water
   (b) Radio active liquids
   (c) Soil waste
   (d) Rainwater
3) Gas
4) Compressed air
5) Mechanical extraction of fumes
6) Electricity
7) Telephones
8) Fire fighting equipment.

CHARACTERISTICS OF SERVICES

Water Supply

The water is supplied by the City Council. It is collected in storage tanks within the building. In this particular project, I have proposed a separate tank of water for every unit. The tanks are stored in pent houses on the roof. The individual provision eliminates the overloard on tanks when new units are put up as the author proposes. It also means that a repair to one unit does not disrrupt other functions going on in other units.

GAS

Laboratory gas is supplied by private organisations. The storage cylinder are ususally located outside the building, this is due to fire risk and also because of filling of the tanks when the gas is finished. The location has to be accessible by the gas trucks. I therefore propose the use of the present central supply system on the campus. I also propose an emargency generating plant to be installed on level one of the big laboratory.

DRAINAGE OF WASTE

Laboratory drainage cannot be allowed to go into the normal drainage system without treatment. The author proposes a dilution tank outside the building and use of catchpots within the laboratory to prevent broken glass from blocking pipe and recovery of valuable chemicals like mercury if run down the sink. Slope of the piping is 1.50.

RADIO ACTIVE DRAINAGE

The substances are not allowed into the sewer line and therefore the author proposes a separate septic tank for radioactive drainage. For long half-life liquid wastes, they are stored in special containers until sufficiently in active before disposing into the drains.

SOIL WASTE: This connected up into the sewer line. There are no problems since the toilets start on level two.

RAIN WATER - Rain water is drained off from the roofs into the down pipes on the perifery of the building between the double columns.

EXTRACTION OF FUMES:

The risk of people's lives and accidents is greater in fume cupboards than anywhere else in the laboratory. This means that there should be efficient extraction of the fumes. The author has also avoided the danger of explosion of gases by having separate extraction ducts.

ELECTRICITY

Electricity is supplied by the East African Power and Lighting. The proposal for the project is surface wiring. This is both for lighting and power. This method eliminates possible destruction of wiring in the case of change of use of space like extending the partition walls. This is particularly in the office/Laboratory. For the laboratories, the power is the pendant type with multi-socket head. Laboratories need a high daylight factor, this will therefore be provided by electricity. The lighting tubes are installed between the double beams.

TELEPHONES: These are installed in the offices only. The wiring is taken off from the campus central switchboard housed in the physical sciences building. The wiring is done through the condiit provided along the window seal. sill.

FIRE FIGHTING - The systems used are :- Hose reel, dry riser and the sprinder system.

SAFETY SHOWERS: These are provided in the laboratories, along the corridor. There is no need to allow for drainage channels on floor, since if the water can be wiped out.

STRUCTURE:

As it is mentioned earlier, the amount of servicing in the laboratory can determine the type of structure. The use of two columns in the design indicates this idea. The use of the two columns make the building look heavy, but I have reconciled this by using thin columns.

BUILDING MATERIALS

The development of economical standard structures and low cost target are a necessary entity, but does not have much application to the University Architecture. This is so because, a University could be judged by the quality and complexity of its Architecture. The use of durable building materials is therefore necessary. I propose the use of concrete and block work. Reinforced concrete structures are very durable and could be used differently to give different shades.

FINISHES

Floors: This should be chosen to show in general terms the corrosion resistance and wearing qualities.

Linoleum - It is because of protection they give against spillage liquids that sheet materials such as linoleum is chosen. It is also cheap and can be washed or polished. Linoleum is used in radio isotope laboratories where it is highly polished.

It presents few joints through which seepage to the sub-floor occur.

Bench top : Laminated plastic,
Teak.
The finish should be easy to wash and resistant to stains.

Fume cupboards: Compressed asbestos cement board or vitreous tiles.

Service lines: Cold water - P.V.C.
Drains wastes-Polyurithane.

Painting : Painted surfaces like walls, ceiling must be protected against exposure to heavy concentration of fumes or where corrosive liquids are to be spilled. Metal surfaces like parts of lighting fittings, furniture, fume capboards, are protected by paints based on epoxy resins. The paints give good resistance to most forms of chemical attack.

Strippable paints are widely used in fume cupboards. The paint is removed and destroyed when contaminated.

INTERNAL FINISHES

ROOM	FLOOR	WALLS	CEILING	FRAMES	LIGHTING	REMARKS
LECTURE THEATRE	Timber, Screed, Carpet	Block wall Timber.	Acoustic tiles	Timber. Aluminium.	Recessed fittings.	
SEMINAR ROOMS	Cement Screed. P.V.C. tiles	Sand-cement plaster. Paint.	Acoustic tiles	Timber. Aluminium Casement.	Fluorescent tubes	
GENERAL LABORATORY	Linoleum Sheets	Block wall Plaster Epoxy paint	Screed, acoustic tiles	Timber, Aluminium Casement	Fluorescent tubes	
PREP. ROOM.	Linoleum sheets	Block wall plaster, Paint	Acoustic tiles	Timber, Aluminium Casement for Windows	Fluorescent tubes.	
RADIO-ISOTOPE LAB.	linoleum sheets highly polished	Heavy block work, screed epoxy Paint.	Screed, Paint.	Aluminium, Timber	Fluorescent tubes.	
BALANCE & INSTRUMENT ROOM.	Linoleum Terrazzo bench top	Block work screed and paint	Acoustic tiles	Aluminium with Rubber for shock absorbers.	Fluorescent tubes.	
ENVIRONMENTAL ROOM.	Terrazzo	TERRAZO	SCREED	TIMBER	Tungstein bulbs.	
STERILE ROOMS	"	"	"	"	"	
DARK ROOM ELECTRON MICROSCOPE ROOM.	Linoleum Sheets	Heavy block wall, Black Paint.	Screed, Black paint.	Timber free swing	Fluorescent tubes.	
OFFICES.	P.V.C. tiles, Carpet	Block wall, Screed	Acoustic tiles	Timber, Aluminium	Fluorescent tubes	

EXTERNAL FINISHES

ROOM	FLOOR COLUMNS	WALLS	CEILING ROOF	FRAMES	LIGHTING	REMARKS
LECTURE THEATRE	R.C. Bush-hammered Blasal sheets	Block work sprayed with slurry	Flat roof, bituminous felt Gravel	Timber with Preservative	—	
SEMINAR ROOMS	R C Bush-hammered Blasal sheets	Block-work sprayed with slurry	"	Timber and Aluminium casement.	—	
GENERAL LABORATORY	R. C Bush-hammered Blasal sheets	Block work sprayed with slurry	Flat roof. Bituminous felt and Gravel.	Timber Aluminium		
PREP. ROOM	"	"	"	"		
RADIO-ISOTOPE LAB.	R. C Bush-hammer	Double walls sprayed with slurry	Flat roof, Bituminous felt.	Aluminium Casement		
BALANCE AND INSTRUMENT ROOM	"	"	"	"		

DESIGNS DEVELOPMENT

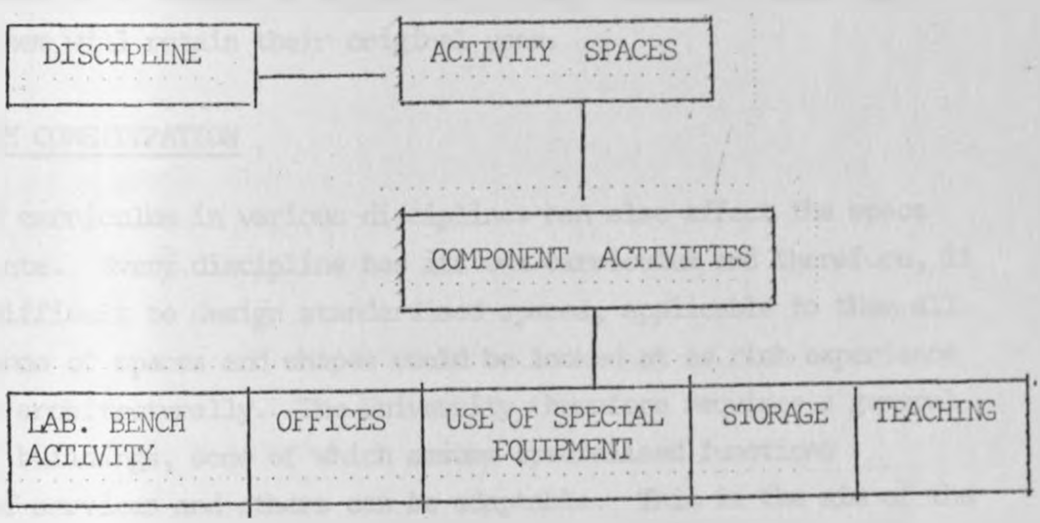
In carrying out the survey and observation on the existing facilities, I had the following aspects in mind :-

1) Functional Adequacy
2) Physical Condition
3) Efficiency of use
4) Potential for expansion

To avoid duplicating of facilities in the University, a comprehensive system has got to be worked out bearing in mind the above aspects, and- are analysed as below.

ACTIVITY SPACES

Before spaces are generally grouped, there is usually a preliminary scheduling that depends on the activities. Separation of activities into groups that have something in common. This is done in every discipline.



Each group of component activities comprises of an activity requiring space allocation, e.g. A research Unit or teaching lab. with its associated requirements.

Component Activity characteristics :

(a) Time - day, night, continuous, occasional etc.
(b) Population - peak and average
(c) Fixtures and equipment.

Activity Space relationship

1) Temporally
2) Proximity
3) Policy relationship

Activity Space Environment

1) Thermal Conditions
2) Visual Conditions
3) Acoustic

SPACE REQUIRMENTS

If the building is to function efficiently, its design must be related as closely as possible to the work which goes on around it. There is always a tendency to standardise all the spaces. In a University, there are some spaces which will be retained by a particular function even though they are general in design. The efficient spaces ~~therefore~~ must therefore satisfy a range of activities, though because of investiment most of them will retain their original uses.

CARRICULUM CONSIDERATION

The carriculum in various disciplines can also affect the space requirements. Every discipline has its own carriculum and therefore, it will be difficult to design standardised spaces, applicable to them all. The variance of spaces and shapes could be looked at as rich experience of spaces architecturally. The University therefore requires a general system of buildings, some of which assume specialised functions because of services and others can be adaptable. This is the aim of the author's proposal.

UTILIZATION OF SPACE

A well utilized teaching space will allow for :-

1) Convenient arrangement of furniture and equipment.
2) Respond well to current and changing teaching techniques.
3) Adequate light, ventilation and orientation.

ALLOCATION OF SPACE

For the teaching or research laboratories, the principle factors which will determine the space needed are :-

1) The length of the bench
2) The width of the bench
3) Free floor area around it.

The width of the bench is determined by the convenience of use at the other end when using it. Free floor area is determined by the need to allow movement and circulation between benches. Also in the assignment of the areas, we can numerically use what we call, "use factor." This will include a table for floor space per person and bench space. These factors will vary with various tasks. The relevance in this project is that it will help in the arrangement of research spaces. This will give convenience to the users.

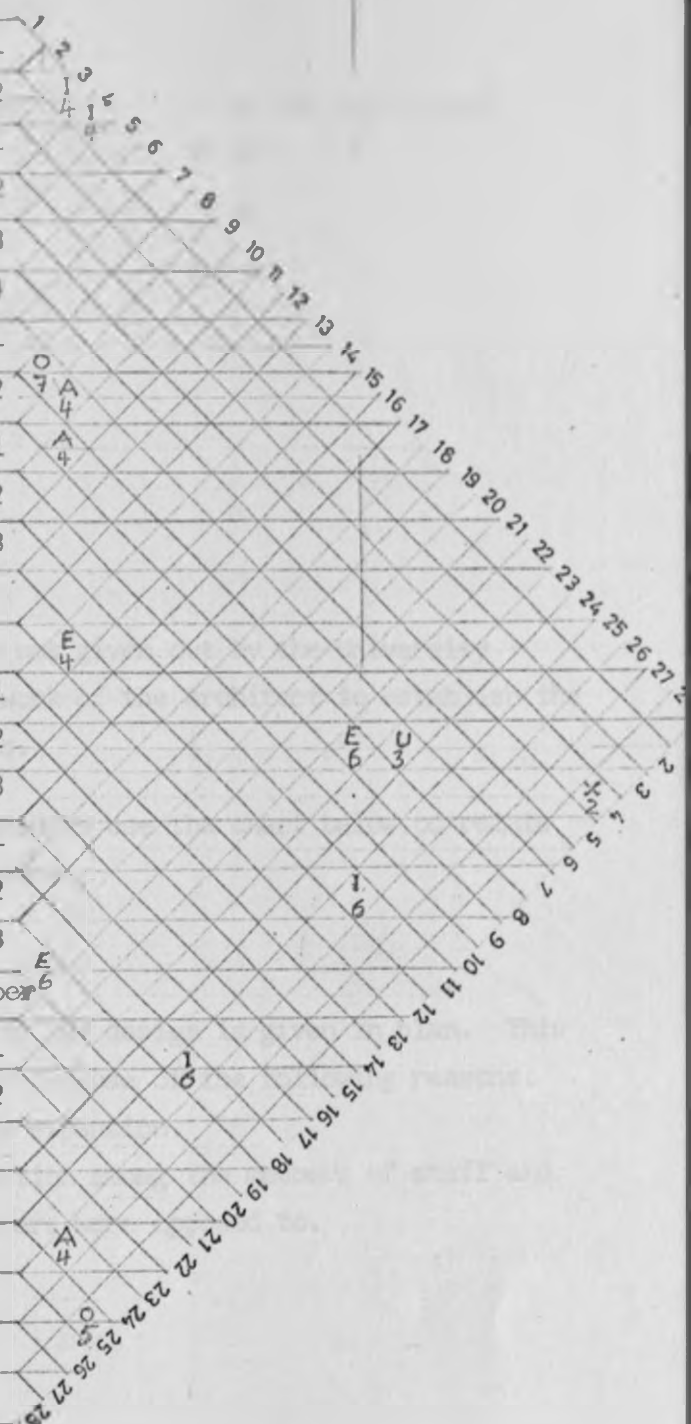
AREA UNIT STANDARDS

In estimating the space required to accommodate these activities, the space standards formulated by the British University Grants Committee, have been applied with slight modifications.

FACILITY	AREA PER WORK PLACE
Lecture theatres with demonstration bench and close or tiered seating	
1. Lecture theatres with demonstration bench and close or tiered seating	
(a) for first 30 students	2.8 m^2
(b) for next 20 students	1.1 m^2
(c) for remainder	0.9 m^2
2. Seminar rooms	1.9 m^2
3. Laboratories:	
1st & 2nd year honours and general	4 m^2 per work place
Final year honours	4 m^2
Research students in group of 4	7.4 m^2 per work place
Advanced or Industrial research	11.0 m^2 per work place
4. Ancillary to laboratories	
Stores and preparation rooms	15% of lab. space
other teaching or research ancillaries	20% of lab area.

ROOM ASSOCIATION DATA.

1.	Lecture theatre	No.1
2.	Lecture theatre	No.2
3.	Seminar room	No.1
4.	Seminar room	No.2
5.	Seminar room	No.3
6.	Seminar room	No.4
7.	General laboratory	No.1
8.	General laboratory	No.2
9.	Preparation room	No.1
10.	Preparation room	No.2
11.	Preparation room	No.3
12.	Radio Isotope laboratory 1	
13.	Balance and Instrument room	
14.	Environmental room	No.1
15.	Environmental room	No.2
16.	Environmental room	No.3
17.	Sterile room	No.1
18.	Sterile room	No.2
19.	Sterile room	No.3
20.	Dark room & Electron Microscope	
21.	Preparation store	No.1
22.	Preparation store	No.2
23.	Administration suit	
24.	Reading room	
25.	Physiology Laboratory	
26.	Biology/Physiology Post-Graduate laboratory.	
27.	Statistical and Computer	
28.	Staff office/Labs.	



Reasons Governing Closeness ration.

CODE	REASON
1	Personal contact
2	Noise level
3	Visitors
4	Convenience
5	Supervisory Control
6	Use of supplies
7	Share same facilities

Closeness rating

VALUE	CLOSENESS
A	Absolutely necessa
E	Especially importa
I	Important
O	Average Satisfies
U	Unimportant
X	Undesirable

FACILITY		AREA PER WORK PLACE
5. Academic staff (ext. any private laboratory)		
Professor or Head of Department	-	18 m^2 per work place
6. Reader or Senior lecture	-	14 m^2
7. Other teaching staff	-	9 m^2
8. Secretarial or clerical	-	5.6 m^2

ROOM ASSOCIATION

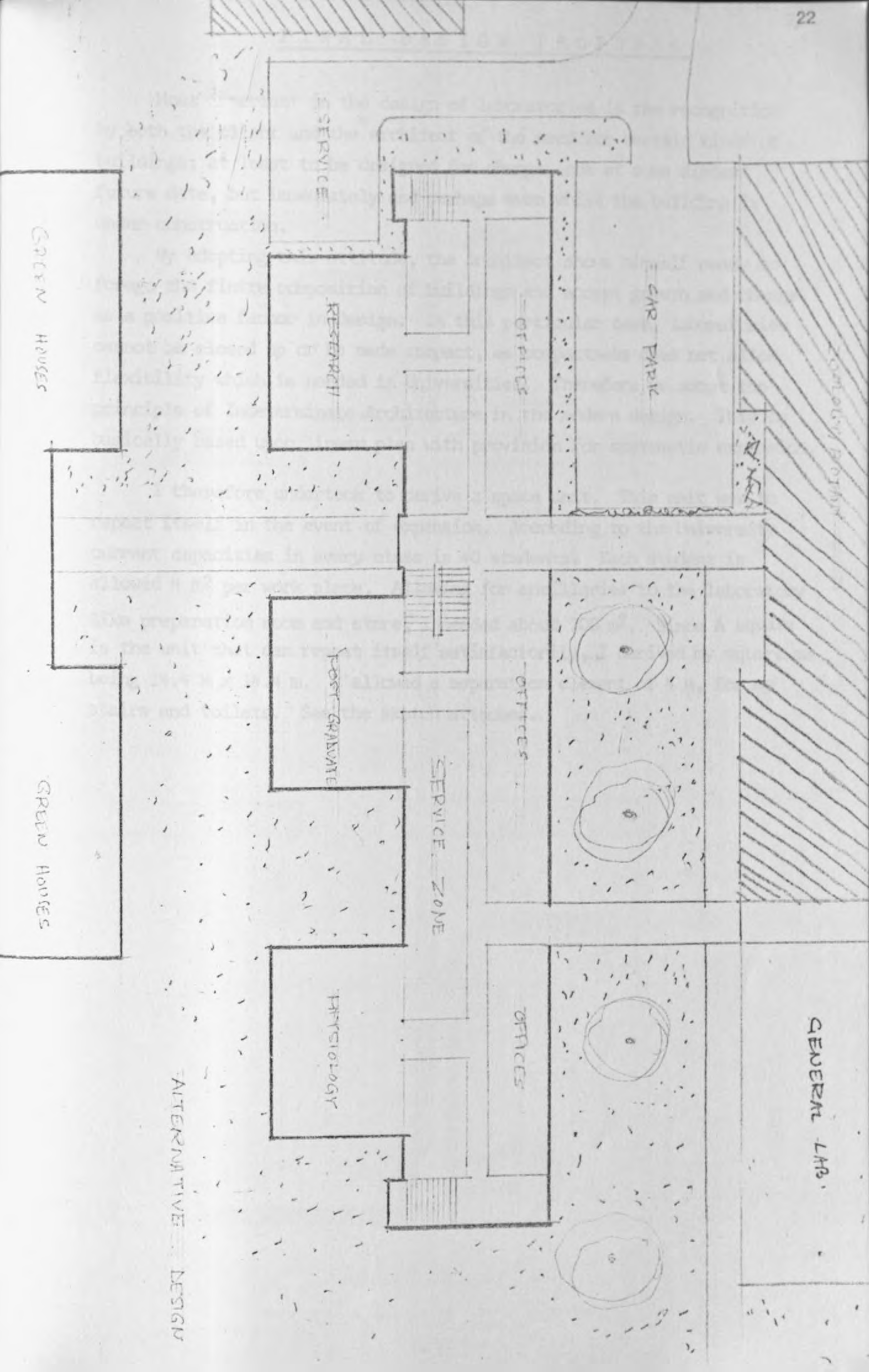
The schedule of Accommodation was given out by the University Building Sub-committee. It is the work of the Architect to establish the right relationship in the facilities.

The author therefore has decided to use the chart below to relate the facilities with established reasons.

DESIGN PROPOSAL

One of the initial proposals of the design is given in plan. This proposal was not very much developed because of the following reasons.

1) It was found rigid to any expansion.
2) There was alot of Interaction among the members of staff and students which the lecturers were opposed to.

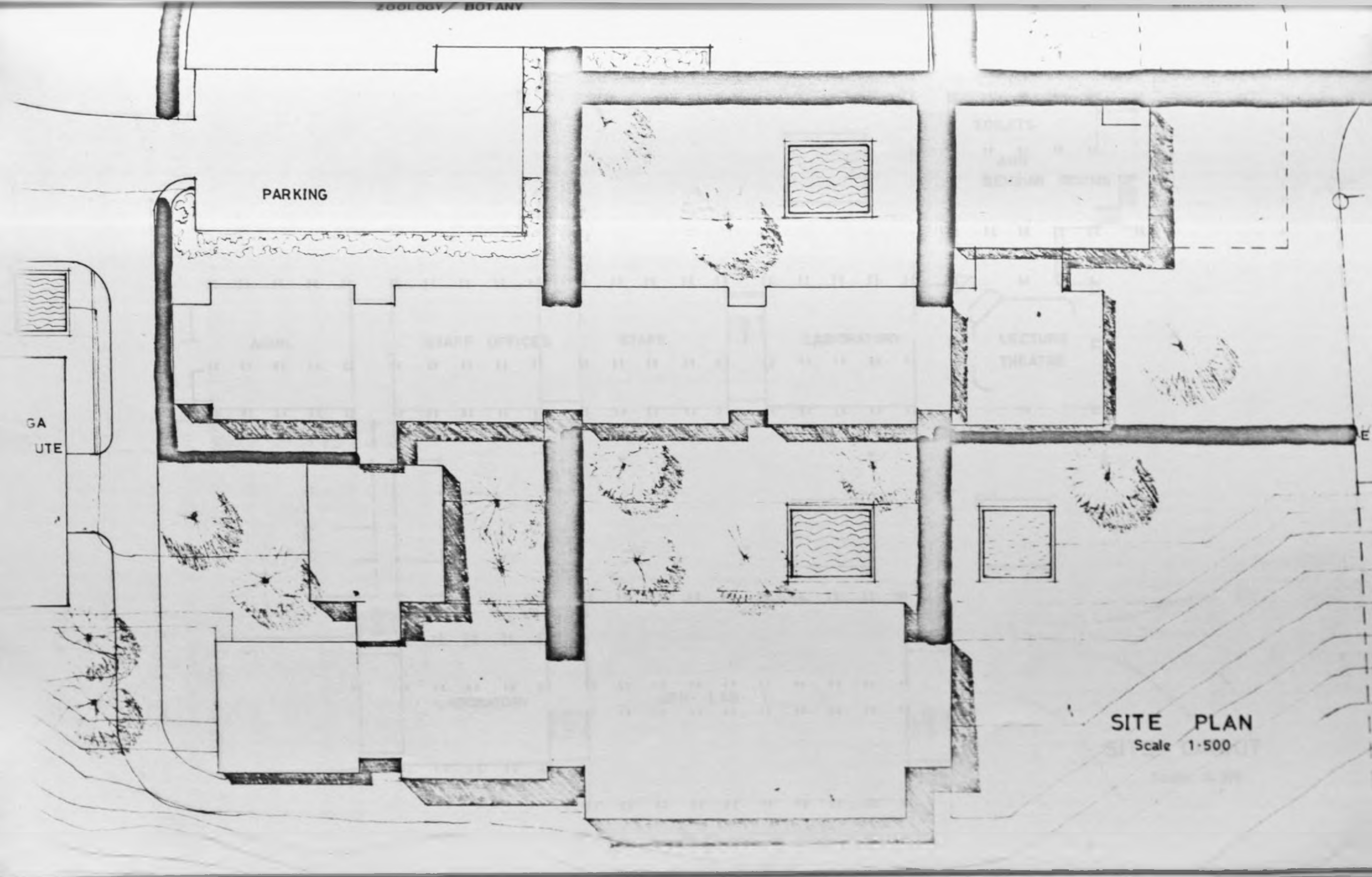

GREEN HOUSES
GREEN HOUSES
SERVICE
RESEARCH
POST GRADUATE
PHYSIOLOGY
SERVICE ZONE
OFFICES
OFFICES
OFFICES
CAR PARK
GENERAL LAB.
ALTERNATIVE DESIGN

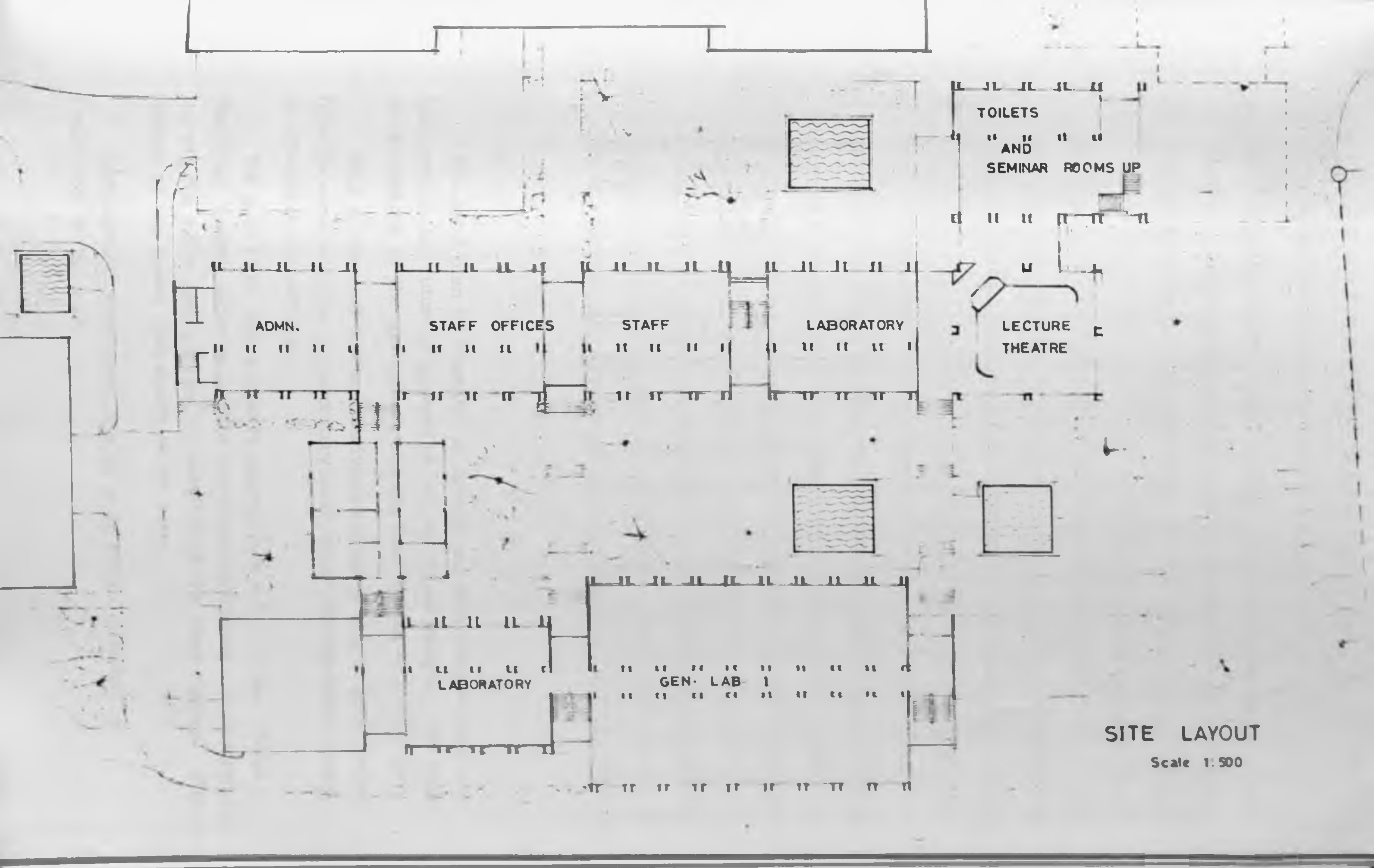
FINAL DESIGN PROPOSAL

Most important in the design of laboratories is the recognition by both the client and the Architect of the need for certain kinds of buildings; at least to be designed for change, not at some distant future date, but immediately and perhaps even while the building is under construction.

By adopting this attitude, the architect shows himself ready to forego the finite composition of buildings and accept growth and change as a positive factor in design. In this particular case, laboratories cannot be closed up or be made compact, as compactness does not allow flexibility which is needed in Universities. Therefore we adopt the principle of Indeterminate Architecture in the modern design. This is basically based upon linear plan with provision for systematic expansion.

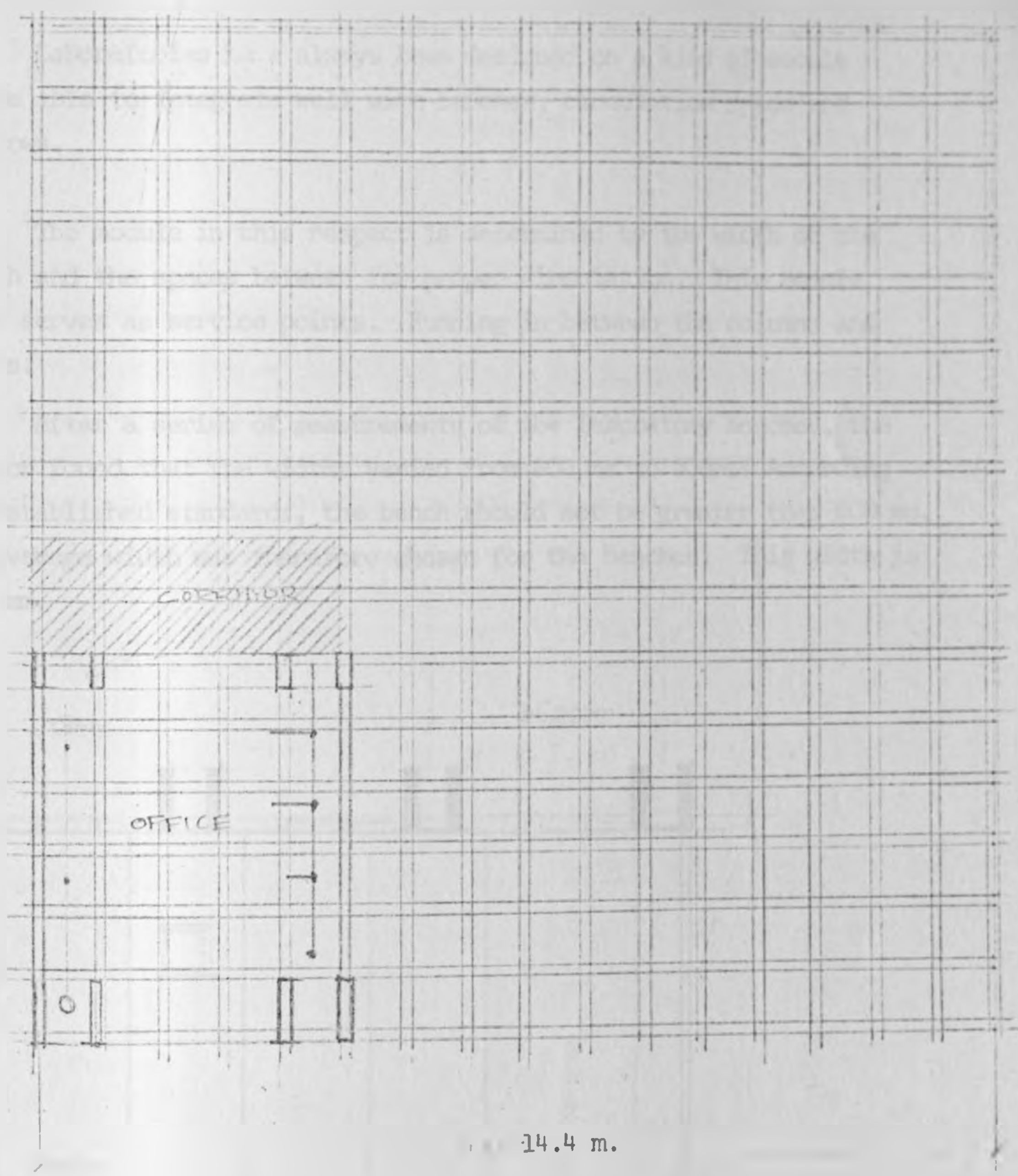
I therefore undertook to derive a space unit. This unit was to repeat itself in the event of expansion. According to the University current capacities in every class is 40 students. Each student is allowed 4 m^2 per work place. Allowing for ancillaries to the laboratory like preparation room and store, I needed about 200 m^2. Since A square is the unit that can repeat itself satisfactorily, I derived my square as being 14.4 m x 14.4 m. I allowed a separation element of 4 m, for my stairs and toilets. See the sketch attached.


ZOOLOGY / BOTANY
PARKING
GA
UTE
SITE PLAN
Scale 1·500



SITE LAYOUT

Scale 1:500



The above plan is schematic in concept and when detailed will suit both present and future programmes as well as future changes. The basis of the concept is the open plan frame, non-load bearing wall structure.

This system that has been derived consists of regular grid derived from the considerations of laboratory bench space and segregated system of structures and services.

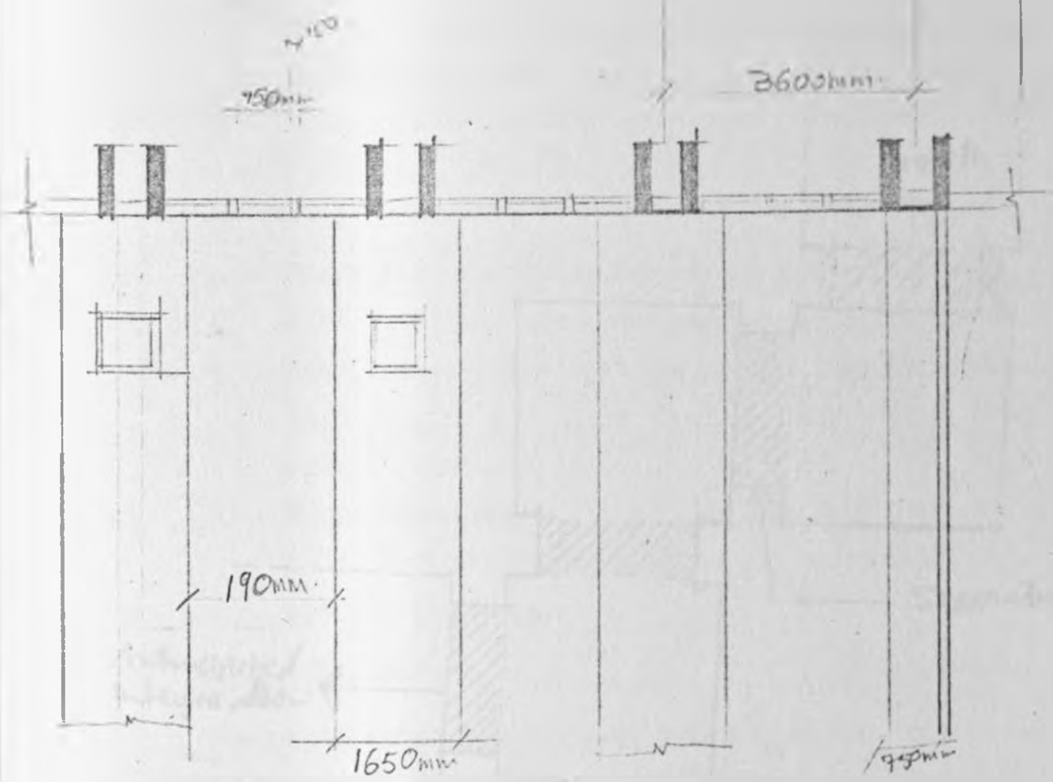
The grid forms 14.4 m squares separated by 4.0 m strips. These separating element serve as service and circulation areas. In the general layout, the author uses parking on level one of the lower complex. This is because of the guarry that exists on the site.

Architectural development can go on in stages or phases by a multi-ple of the unit.

Laboratories have always been designed on a kind of module to be able to integrate well with benches, circulation space and windows.

The module in this respect is determined by the width of the bench and the spaces between for proper circulation. This module also serves as service points. Running in between the columns and beams.

After a series of measurements of the laboratory benches, the author found that the widths varied from 600 mm to 900mm. According to established standards, the bench should not be greater than 800 mm. An average width was therefore chosen for the benches. This width is 750 mm.



Double bench arrangement.

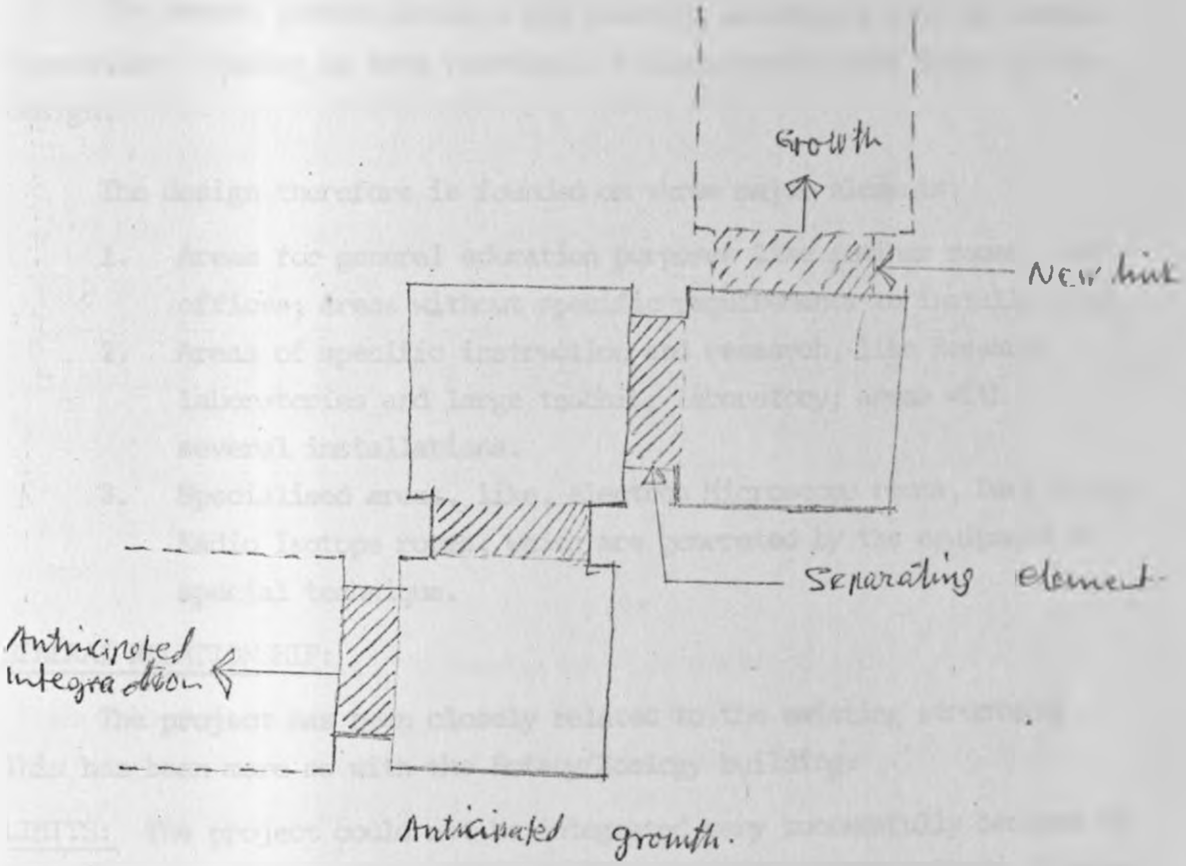
RENOVATION AND EXPANSION

Most of the University requirements for expansion that are contemplated for in the near future lies mainly in the renovation and up dating of present facilities or additions to existing facilities.

In many cases the conversion will be necessary e.g. Geography Department move into the chemistry laboratory or a Hall of residence into an administration block.

The possibility of linking adjoining building winds to provide for extra space is also very important if such idea was thought of by the Architect. In this proposal the designer has envisaged the kind of expansion that will take place in the design. This is growth by units. See detailed plans.

e.g.



PROJECT EVALUATION

General: The success of the building system depends on how well the unit within the system functions or performs. To be able to evaluate the project, the writer had two things in mind.

1. The user's reactions to the building.
2. Architect's own evaluation in the light of his success in the design.

In the case of the user's reaction or general feedback, it is best achieved when the building is completed and is under use. However, I managed to get two of the client's representative make their views. One of them favoured the system I had derived, where each unit is an entity of its own. This meant spliting the class into manageable sizes.

The second person wanted a big teaching laboratory with an overall supervisor. Taking up both reactions, I incooperated both ideas in the design.

The design therefore is founded on three major elements.

1. Areas for general education purposes like seminar rooms, and offices; areas without specific requirements to installations.
2. Areas of specific instruction and research, like Research laboratories and large teaching laboratory; areas with several installations.
3. Specialised areas, like, electron Microscope rooms, Dark rooms, Radio Isotope rooms; which are generated by the equipment or special technique.

GENERAL RELATIONSHIP:

The project has been closely related to the existing structures. This has been more so with the Botany/Zoology building.

LIMITS: The project could not be integrated very successfully because of the steepness of the site. Although there is the covered walkway linking the Zoology/Botany block, and the proposed buildings, this could not be continued because of the site levels.

STRUCTURES: The structure was worked out with services being given the priority. This made the structure have two columns. This gives amble space for flexibility in the installation of services; both between columns and beams. This enables the services to be introduced or removed without any problems.

LIMITS: The structure has its own limits in the sense that it cannot take up horizontal servicing conveniently. It also makes the building look heavy. This aspect has been reconciled by the use of thin columns as shown on plan.

SERVICES: Servicing is the basic element in the laboratory design. This has formed the skeleton of the project. The distribution of services has been split into two major zones.

Periferal Zone for wet services - water, drainage etc.
Internal Zone for dry services - Electricity, gases.

The wet services have been kept in external columns as much as possible. This zoning reduces the risks of shocks and corrosion. This zoning functions well particularly with large teaching laboratory.

In the case of deep rooms and fume cupboard areas, artificial ventilation and lighting has been used.

It was not the intention of the Designer to provide the building with mechanical ventilation, system, but the possibility of installing such services has been allowed for. For example a fume cupboard could be installed on top of a bench, and the duct runs between the beams, up to the extraction fan. The building therefore functions well in servicing.

The lecture theatre which has a completely different function fits well into the system; but without windows. The double beams forming the roof structure allows for the installation of the ventilation ducts.

Finally, I should comment, that the building system has been reasonably resolved for the functions that go on in it. The solution however is not exhaustive, and therefore more ideas are still welcome to the perfection of the system.

CONCLUSION

From the facts established, both from the survey and observation, the major principle on the internal layout of laboratory spaces is that it should be possible for the users to make changes without outside specialist's help.

This means that in the proposal, the integration of components has been kept to a minimum. This is achieved by, use of movable drawer units, movable tables, and no fixing permanently of any equipment on the floor, or wall. This however does not apply to the specialised areas like the Electron microscope room which is generated by the equipment.

The primary servicing is through double columns and joints to lead on to the bench. Electricity is via the double beams.

The project has the functional relationship and implication of continuous space in academic patterns of teaching and research areas. There is no specific academic identifications except in the large laboratory, but there is an inter change of use.

This continuity of build by small service and circulation cores eases progress towards the academic and social interaction which characterises a successful University.

APPENDIX I

BIOLOGICAL SCIENCES COMPLEX SCHEDULE OF ACCOMMODATION

FUNCTION	AREA SQ. M.	AREA SQ. FT.
A. THEATRES AND ANCILLIARIES		
Lecture Theatre No. 1	157	1,590
Lecture Theatre No. 2	110	1,190
Seminar Room No. 1	37	402
Seminar Room No. 2	37	402
Seminar Room No. 3	37	402
Seminar Room No. 4	37	402
Sub Total	415	4,488
B. LABORATORIES AND ANCILLIARIES		
General Laboratory No. 1	690	7,500
Preparation Room No. 1	24	261
Preparation Store No. 1	60	652
Dark Room and Electron Microscope	28	308
General Laboratory No. 2	690	7,500
Preparation Room No. 2	24	261
Preparation Store No.2	60	652
Steril Room No. 1	10	108
Steril Room No. 2	10	108
Environmental Room No. 1	10	108
Environmental Room No. 2	10	108
Physiology Laboratory	186	2,021
Preparation Room No. 3	10	108
Preparation Store No.3	25	272
Biology/Physiology Post Graduate Laboratory	72	782
Balance and Instrument Room	56	608
Sterile Room No. 3	10	108
Environment Room No. 3	10	108
Sub Total	2,037	22,141

FUNCTION	AREA SQ. M.	AREA SQ. FT.
C. ACADEMIC STAFF ACCOMMODATION		
Combined Offices and Laboratories for 35 members of Staff	204	222
Sub Total	714	7,760
D. TEACHING AND RESEARCH ANCILLIARY BUILDINGS		
1. DEPARTMENT OF BOTANY		
Green House No. 1	99.2	1,078
Green House No. 2	99.2	1,078
Green House No. 3	99.2	1,078
Green House No. 4	99.2	1,078
Green House No. 5	11.4	124
Green House No. 6	11.4	124
Green House No. 7	11.4	124
Green House No. 8	11.4	124
Head House	158.7	1,725
Sub Total	601	6,533
II. DEPARTMENT OF ZOOLOGY		
Fresh Water Aquarium	64.4	700
Salt Water Aquarium	59.8	650
Tilapia Reservoir	73.6	800
	197.8	2,150

FUNCTION	AREA SQ. M.	SQ. FT.
III. DEPARTMENT OF ENTOMOLOGY		
PLANT FEEDERS		
Green Houses	50	534.4
Insectary I	25	272
Insectary 2	25	272
Insectary 3	25	272
Adult Holding	10	108
Egg Infestitation	7	76
Egg Sterilisation	7	76
Larvae	10	108
Diet Store	4	43
BLOOD SUCKERS		
Animal House	50	534
Insectary 1	15	163
Insectary 2	15	163
Insectary 3	15	163
Insectary 4	15	163
Handling Room	15	163
Feeding Room	15	163
Common Room	15	163
Washing Room	15	163
Diet Preparation Room	15	163
Changing and Toilets	7	
Sub Total	348	378
E. ADMINISTRATIVE SUITE		
Administrative Office		
Chairman		
Chairman		
Chairman		
4 Secretaries (typing pool)		
Xerox and duplicating		
Store for Stationary		
Sub Total	190	
Gross Total	4,502	

APPENDIX II

SUBJECT: DATA COLLECTION ON EXISTING LABORATORIES

INTRODUCTION:

In designing a complex building like a biological laboratory, there are thousands of items to be considered in relation to each other; it will be easy therefore to overlook or misinterpret the relations. It is therefore important for one to be conversant with the current development in laboratory design. This could be achieved by talking with the laboratory Managers, Technitians and other relevant Scientists whose information would be very valuable. In the circumstances where they may be reluctant to give the information, a set of well directed questions usually evoke information.

I have therefore set out visiting some of the best laboratories in the country on a fact finding mission. To enable me do this work properly. I have got a set of questionnaire to give me specific details.

QUESTIONNAIRE ON EXISTING LABORATORIES:

1. Name of Laboratory : ....
2. Location : ....
3. Type of Education taken/Research: ....
4. Date completed: ....
5. Number of building in research group; if more than one why? ....
6. Orientation: ....
7. Type and size of window per module: ....
8. Number of storeys: ....
9. Floor - to - ceiling height: ....
10. Floor - to - floor height: ....
11. Laboratory module: ....
12. Laboratory depth: ....
13. Bench height: ....
14. Bench width: ....
15. Bench top material and finish : ....

16. Extend of standardisation of laboratory layouts and fittings:

....

17. Number of occupants per standard laboratory : ....

18. Size and number of laboratory offices and location in relation to laboratories: ....

19. What services are provided and in what position are they reticulted?:

....

20. Number of outlets per bench: ....

21. Is water pressure controlled: ....

22. Laboratory effluent - type of system, including neutraliser:

....

23. Position of fume cupboard and details of exhaust systems ....

....

24. Air conditioning - type of system and distribution; number of air changes; recirculation: ....

25. Does overall arrangement provide satisfactory inter-relationship between laboratories and other functions - store, workshops?: ....

....

26. How have they solved the problem of storing laboratory chemicals, equipment, test specimens, research data and correspondence?: ....

....

27. Hazardous Chemicals - maximum quantity permitted in one laboratory and where kept: ....

28. Where are secondary and bulk supplies stored?: ....

29. Flammable solvents - maximum quantity permitted in one laboratory, and where kept?: ....

30. What special efforts have been made to simplify housekeeping and maintenance: ....

31. Any other item of particular interes : ....

PHOTO V: Practical and Teaching laboratory at Chiromo one of which the above questionnaire was performed.

PHOTO VI: Post-graduate laboratory at Chiromo used as a case study.

PHOTO VII: Lecturer's office. laboratory in the Botany / Zoology block used in the case study.

APPENDIX III

PLANNING POLICY

NATIONAL PLANNING

In view of the magnitude of the National Planning efforts in educational development, a University plan including building facilities and their construction is essential. The capacity of the University to provide the country with the required skilled manpower as well as other materials from research centres will determine the success of the building programme.

A standardized approach to building can produce economies and should be used where applicable. Location of faculties to serve their specialities best, continuity of program and practicability of needs all rely on the University planning.

UNIVERSITY INTEGRATION

Education as a University unifying force, literally taken can lead to the provision of such facilities as large meeting halls, lecture rooms, seminar rooms and open yards for both special disciplines and University community use where the spirit of togetherness among students and staff could be encouraged, en masse.

More subtely the concepts behind the buildings and their contents can reflect the desirable aspects of the University identity which commands both National and International quality.

PROMOTION OF THE SOCIAL EQUALITY

The University is an institution of international repute and character because of the multi-racial combination and therefore we shoul encourage freedom of speech, freedom of movement etc. The building system must therefore be designed to cultivate these aspects. This is done by communal activities like eating, playing, talking and other free time facilities that encourage fraternity.

INCREASE IN EDUCATIONAL QUALITY

Increased quality of educational methods often makes demand on the University buildings that cannot easily be met by the present or traditional structures. Providing a good teaching environment will not necessarily ensure the success of a program but poor facilities will certainly affect the improvement of quality. Coincidentally, the structure more adaptable to modern programs are often less expensive than traditional structures.

A P P E N D I X IV

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