A THESIS

Presented to the Departmcnt of Architecture

Faculty of Environmental Design

of

Ahnadu Be 11 o Uh ive rs ity

Zaria

in partial fulfilncnt of the requirements for the

Degree of Master of Science in Architecture

By

Daniel Attah AGAMAH

"National Centre for Scientific Research said Development"

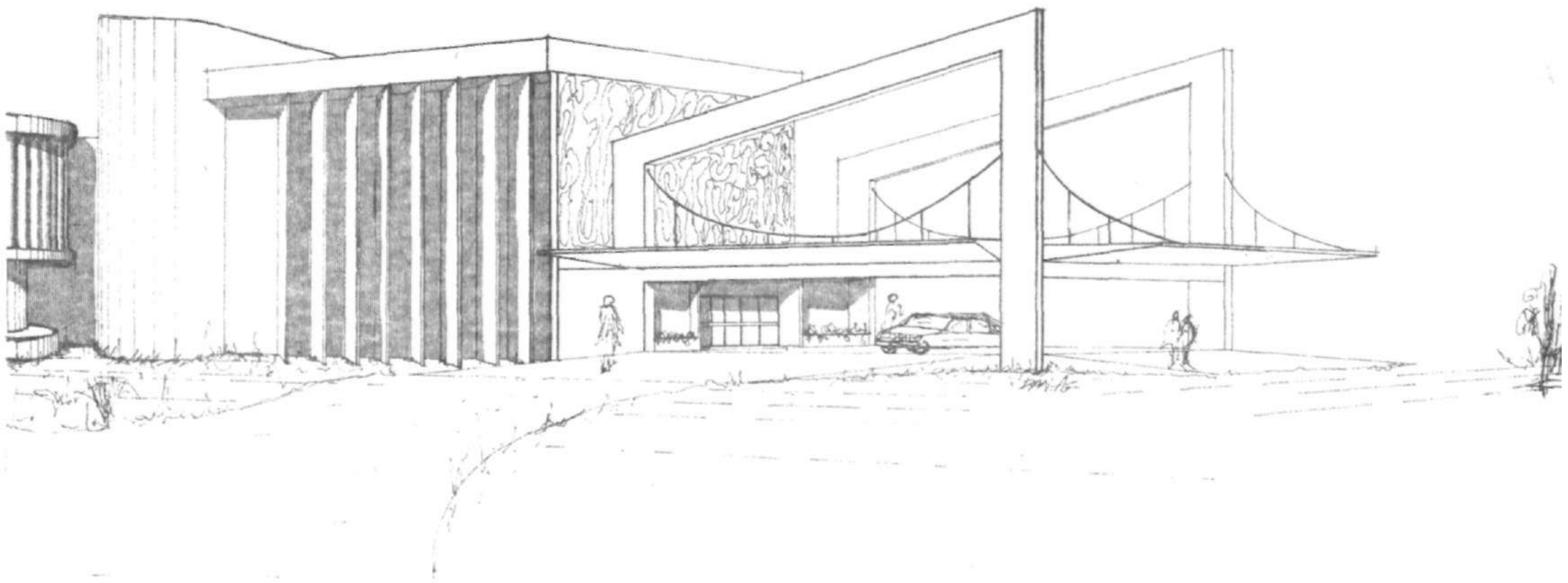
in

June, 1976

Accepted By: _____

Head of Department
Architecture

External Exaniner/S



An artist impression of the main entrance of the "National Centre for Scientific Research & Dev." proposed in this Thesis

SYNOPSIS

This scheme is purely a hypothetical academic exercise but has some practical intentions. Its theme is on "built Scientific Research Facilities". The proposals are for Nigeria end to bo sited in Kaduna, in lieu of "Land -Use maps" for the New Federal Territory which was the first choice of location.

It is common knowledge that in the struggles for the overall development of the Nigerian nation, the role of Science and Technology is crucial throughout the span of every development programme. For the desirable national self-reliance to be achieved one considers the acquiring and building up of scientific and technolaical skills and knowledge very fundamental and imperative. The required skills and first-hand knowledge can only be acquired and developed through elaborate and sustained research. The need for a centre for Scientific Reseach is thus established.

Consequently, a "National Centre for Scientific Research and Development" is being proposed and designed in this scheme. The main purpose of the scheme is to evolve the planning end design of the Research Centre which will comprise of a complex of inte related laboratories, workshops, offices and other ancillary research facilities within a flexible, adaptiblc and conducive arohitootural setting and environment.

The type of research envisaged and designed for is of inter-disciplinary nature in tho fields of tho physical and chemical sciences, engineering and Technol ogy.

A detailed study of research facilities, especially the laboratories were carried out and on that basis the design of tho Research centre was evolved. Becuase of the universal nature of science and scientific research, the similarity of research procedures and methods and the identical uses of most instruments, equipment and services, the provision of spaces and their fittings have to be rather universally similar. This scheme conforms generally.

The scheme was limited to general interdisciplinary research and development in Science and Technology. For atomic and nuclear reseach,

a separate research institute would be suggested to be set up to compliment the type of interdisciplinary research centre proposed in this scheme. This is because of the very special structure, safety and services requirements of atomic and nuclear research from general scientific research, which if incorporated in the scheme would mount to integrating two big projects Into one.

This text and the Thesis thereof are sincerely dedicated ----------

. Practically to --- my country, Nigeria as a contribution to national development ----------

. Honourably to --- my father and mother through whom I came into existence and to all my five brothers, five sisters, numerous cousins uncles, aunts and other relatives of the AGAMAH Family - part of which I am ---

. Dearly to --- my RUTH, with whom I share every bit of my life ----------

. Reverendly to --- God whom I believe to be Omniscient, Omni-present, Omni-potent, the Creator and Maker of the entire universe and everything therein.

PREFACE AND ACKNOWLEDGEMENTS

The intention of this text is to describe the development of the ideas and proposals for the Thesis. An attempt has been made to give in a fairly detailed outline, the relevant studies carried out as the basis for the architectural design - the most important end-product for the degree sought.

The Thesis being on "built facilities" for Scientific research had some inherent difficulties because of its technical nature requiring both or at least one of either the sufficient scientific knowledge of scientific research in order to know most practical requirements or the practical architectural experience of at least a designed and built Research centre - none of which I had to wield. Consequently for the technical and specially scientific aspects of the text I relied very much on the books I could lay my hands on and such informations or citations have been duly acknowledged and foot-noted. All the books or magazines consulted are indicated in the "Bibliography" at the end of the text. Special mention must be made of the considerable amount of information on Research Laboratories for which I am highly indebted to:
"The Design of Research Laboratories", published by the Oxford University Press for the Nuffield Foundations; "Practical Laboratory Planning", by W.R. Ferguson and published by Applied Science Publishers Ltd., London. Similary, for the site planning principles, some basic concept of the "growth pattern" used for the design I am indebted to "University Planning and Design", published by Lund Humphries for the Architectural Association, London.

I wish to thank the Nigerian Council for Science and Technology, especially the Principal Scientific Secretary, Mr.F.N.C. Okagbue for some vital information and contribution in streamlining my ideas for the proposals to conform to official national objectives in Science and Technology. My thanks go to the staff of the International Institute of Tropical Agriculture, Ibadan for the provisions made during my "educational visit" there.

Similarly I thank all the lecturers in the Faculty of Science, A.B.U., with whom I had some background discussions.

In the Faculty of Environmental Design I wish to thank my mentor, Mr. C.S. John for his detailed guidance in all aspects of the scheme; Prof. E.A. Adeyemi, the Head of Department; Mr. Gniadzik; Mallam T. Sa'ad; Mrs. M.A.D. Urbanowicz; Mr. S. Ehrlich, to mention a few for their contributions by way of suggestions and criticisms. They served as positive turning points in the design. Similarly I wish to thank all my colleagues, especially those of our number who worked in the studio - the "studio architects" and some of the "bed-room architects" who called at the studio frequently.

I wish to sincerely thank Mr. D.M. Ikani, Academic Office A.B.U., Zaria for the excellent job done in typing this text. Similarly I am grateful to Mrs. R.O. Adejoh and her assistant, Nathaniel, Surveying Department, for helping to transfer the drawings to stencils.

Finally, I thank all well wishers especially relatives and friends. Special mention must be made of my fiancee, Ruth, for her invaluable moral support at all times.

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May 1982

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

The development and continued existence of any nation is dependent on its economy and security. The state of the Economy and security of any nation depends on how developed that country's real and potential economic and human resources are. Nigeria is struggling to develop into a virile and self-reliant nation. The fundamental and dominant role of Science and Technology in the struggle is common knowledge and should not be overemphasized. Science and Technology are dynamic and are always developing through research.

For a developing nation like Nigeria (and any nation for that matter), an emphasis on Scientific Research and Development is crucial for its struggle for national security and economic development and she needs the efficient architectural provisions without which the scientists would not be able to work towards positive achievements. The architecture of research amenities, is therefore a field that deserves the resourceful attention, organizational skill and dedication of architects. Hence the choice of the topic "National Centre for Scientific Research and Development" for this Thesis. The scheme is a hypothetical attempt to make a double contribution: firstly to the architecture of Research Buildings and Environment; secondly to the promotion and development of Science and Technology through Research in Nigeria.

The main aim is to evdve the planning and design of a Research Centre which will comprise a complex of inter-related laboratories, workshops, offices and other ancillary research facilities.
The technical and rather special nature of most of the facilities to be designed entailed some further studies.

The scheme was carried out in phases as outlined below:

Phase I - choosing the topic and ratification by the Faculty Board.....

Phase II - Preliminary investigations and drawing up of a tentative brief to guide data collections.

- The preliminary studies were carried out by using the University Library; correspondences to organisations and individuals; and undertaking personal visits to places

of interest relevant to the topic. Among he places visited were the headquarters of the Nigerian Council for Science and Technology, Lagos and the International Institute of Tropical -- Agriculture , Ibadan.

Phase III - Analysis of investigations and data collected.
- Drawing up a brief for the design.
- Preliminary bibliography

Phase IV - Analysis of the Scheme in terms functional, spatial and zoning relationships.
- Analysis of possible sites.

Phase V - Preliminary write -up and documentation, of background studies.

Phase VI - Architectural Design, comprising sketch design of:
- general site layout,
- floor plans
- sections and elevations
-- models
- perspectives
-- Details
- Review of the above with Departmental staff

Phase VII - Final architectural presentation Drawings
- Final draft and type-writing of documentation
- submission of Scheme.

The text is in five main parts, each part dealing with related aspects of the scheme. Each part may comprise more than one chapter: Part I is on "Background and Motivation". It comprises of two chapters; one giving a general view on Science and Technology, the other is a sort of an account of Scientific research in Nigeria.

Part II is on "General Fundamental Proposals".

The five chapters are on:

(i) The concept and type of research being provided for, giving the justification and validity .....

(ii) The "Statement of purpose", giving the scope of proposed Research centre -.....

(iii) The conceptual organisation and operation of the centre ...

(iv) The special requirements of manpower, funds and land and the proposals to meet their needs .....

(v) The location of the Research Centre, citing national considerations and the problems encountered about the New Federal Territory leading to the choice of Kaduna ...

Part III deals with specificRelated Studies on the facilities to be designed and provided for.

The three chapters are on:

(i) General and ancillary Facilities like administrative offices, the library, publication unit, the computer unit and the television unit. ----------

(ii) Laboratories, pointing out the types and services requirements as well as safety considerations. -------

(iii) Site planning studies, which were based on campus planning ----------

Part IV is on "The Scheme of Design Proposals".

The first chapter is on the final design brief and schedules of accomodation giving flow diagrams to illustrate ----------

The second chapter is on the general site planning principles employed in the design ----------

The third chapter is the design modules established for the laboratory unit and laboratory layout.

The fourth chapter deals more specifically with the actual site in Kaduna and the environmental determinants ----------

The fifth chapter is on the " architectural character" of the design stating the objectives and some features of the design ----------

Part V is the conclusion and gives a brief summary of what was done and what was not done ----------

It is hoped that this scheme would have some meaning and be of of some positive contribution .

PART I

BACKGROUND AND MOTIVATION

Chapter 1 - The perspective

Chapter 2 - Scientific and Technological Research in Nigeria

Part I Chapter 1

THE PERSPECTIVE

1:1:00 From a global perspective, the catalogues of scientific and technological achievements and breakthroughs are ever increasing and unending while the prospects for the future are enormous. Scientists of all disciplines are leaving no stone unturned in the quest for "the truth" to add to or improve upon what is already known. High level and advanced knowledge and skills are being developed and acquired in all scientific and technological fields: the pure sciences, electronics, engineering, technology, aeronautics, medicine, agriculture, computer science and outerspace to name a few.

A simple analysis would show that the best part of the credits for the present world scientific and technological status and "knowledge explosion" goes to the "developed" or technologically advanced countries. These "advanced" countries occupy a rather independent and exporting position in Science and Technology while the "developing countries" are in the dependent phase, importing science and Technology.

1.1.01 Nigeria, like other developing countries is striving to become "developed" and all attempts are being made by the government and all the citizens to succeed.

Nigeria is in the second half of the second decade of her political independence and is faced with many challenging requirements for the development and building of a virile, self-reliant and egalitarian nation.

Nigeria is determined to achieve all her national objectives as outlined by the second National Development Plan and underlined by the current Third National Development Plan 1975 - 80:

> "..... to establish Nigeria firmly as a united, strong and self-reliant nation, a great and dynamic economy, a just and egalitarian society, a land bright and full of opportunities for all citizens, and a free and democratic society." (1)

1.1.02 For Nigeria to achieve the desired "security" and economic status, there is a basic need for her to build up a self-sustaining scientific and technological knowledge, capacity and manpower to meet the national



FIG·1 what the national newspapers say

requirements and develope her potentials in Agriculture, medicine, Industries, Education, conventional and military technologies. This can be done through heavy financial and human investments and channelling as much of our resources as possible into the substructure of science and Technology, namely, Education and Research.

The Nigerian public is desirous to see the nation transformed into a developed, stable and "scientific" nation as can be seen from the series of articles in the national newspapers.

Nigerian scientists, as a special group, meet from time to time, under various themes in conferences and symposia to delibrate on how to build-up a "Nigerian Front" for the advancement of science and Technology in this country and within the context of the universal advancement of the frontiers of knowledge.

The Federal government, as the supreme motive force, is very mindful of the national aspirations and the need for the rapid development of science and Technology and for this reason has set up a council - the Nigerian council for science and Technology (NCST) - to advise her and make proposals for the eventual development of a Nigerian scientific and technological culture.

1.1.03 This decade of the seventies is a decade of preparation and decision for Nigeria and her citizens. It is a decade of great planning and laying of the foundation and infrastructure in all aspects of the national development, on which successive generations will build. One is convinced that Nigeria has the economic potential as well as the basic manpower potential to develope to any conceivable magnitude - politically and technologically.

1.1.04 The enormous task of planning and executing the development programmes demands a thorough understanding of the basis, potentiality and limitation of science and technology. More-so as Science and Technology occupy a central and controlling position in all the national development programmes. Seeing the central and crucial position of Science and Technology, provisions must, therefore, be made for their development, noting that Science and Technology develope through sustained research.

Architects, engineers, surveyors, planners, administrators and economists and indeed everyone has to be involved and make his or her own contribution. Consequently, the effort of this Design Thesis is directed towards making an architectural contribution, even if hypothetical, to the development of Science and Technology in Nigeria by proposing a centre for Scientific research aimed at providing an "anchorage" for National Development bearing in mind the state and direction of scientific research in the country as of now.

Footnotes

(1) Federal Republic of Nigeria, Third National Development Plan 1975 - 80 volume I, The Central Planning Office, Federal Ministry of Economic Development, Lagos 1975. P.29

SCIENTIFIC AND TECHNOLOGICAL RESEARCH IN NIGERIA

1.2.00 It is difficult to give a detailed account of the beginning of scientific research in Nigeria due to the lack of information about the past, in this regard. However, during the colonial period, Nigeria was part of British West African research organisations like the "West African Council for Medical Research" (W.A.C.M.R.)(1) and such organisations were in the fields of applied science relevant to the needs identified by the then colonical governments. After independence in October 1960, the previous research institutions were simply "Nigerianised" with little, if any, operational change.

The establishments 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 cradle of research and knowledge. In order to keep Scientists in the various institutions in the country in touch with one another a voluntary society called the "Science Association of Nigeria (SAN) was formed in 1958. Ten years later it began to publish the "Directory of Scientific Research in Nigeria" to highlight research work and indicate the various scientific interests in Nigerian Universities and research institutes.(2)

For almost ten years after independence, Nigeria lacked an Official national sense of direction in the fields of Science and Technology, until the Federal Government in 1970, set up a national body to oversee and direct the development of Science and Technology.

1.2.01 A New Beginning

The Federal Military Governments promulgation of Decree No.6 establishing as a statutory body, the "NIGERIAN COUNCIL FOR SCIENCE AND TECHNOLOGY" (NCST) in February, 1970, and its inauguration in April of the same year could be considered as the first determined attempt by a Nigerian government to launch a national scientific campaign. This decree repeals Decree No.83 of 1966 which established the "Nigerian Council for Scientific and Industrial Research which was never inaugurated.(3)

The NCST serves two main roles, namely: to determine and advise the Federal Government on a national science policy and to co-ordinate and promote scientific activities in the country as contained in the decree creating it. The six fields of scientific knowledge and research outlined by the government include:(4)

(a) Agricultural sciences

(b) Experimental sciences (physical, chemical and mathematics)

(c) Industrial sciences, Engineering and Technology

(d) Medical sciences

(e) Environmental sciences (Biosciences and Geosciences)

(f) Social sciences

1.2.02 Existing Research Establishments

At the moment, the operational level of research consists of the various University departments, a number of major governmental research establishments and some minor government research units.(5)
The following four government research institutions are autonomous:

(i) Nigerian Institute for Oil Palm Research

(ii) Nigerian Institute for Trypanosomiasis Research (NITR)

(iii) Cocoa Research Institute of Nigeria

(iv) Nigerian Institute for Social and Economic Research (NISER)

All the institutes except NISER which is financed by the Federal government are co-financed by the states and Federal governments. The International Institute of Tropical Agriculture (ITTA) is at present non-governmental and financed from outside. (The Federal Government will eventually take over from the "outsiders"). Other government establishments which have research facilities are all directly financed by their repective Ministries.
Some of such establishments include:

(i) Federal Department of Agricultural Research

(ii) Federal Department of Veterinary Research

(iii) Federal Department of Forestry Research

(iv) Federal Institute of Industrial Research

(v) Federal Land Survey

(vi) Geological Survey

Others based originally on regional or state governments include

(i) Institute of Agricultural Research, A.B.U., Zaria

(ii) Agricutural Research Institute of Ife University

(iii) Agricultural Research, Planning and Special Services Division of Bendel State government

(iv) Agricultural Research and Training Station at Mmudike, Imo State.

The NCST would undertake a review of these establishments and advise on their re-organisation into semi- autonomous institutes to be brought under the aegis of the appropriate Research Councils when established. Such a re-organisation is aimed at removing the research establishments from the exigencies of the civil administration and would ensure free judgement in the promotion and execution of scientific and technological programmes. It would also encourage a feed-back of new ideas to the policy making level. As a "division of labour" principle and in order to effect the national policies in the various research fields, Research Councils have been formed to take care of specific fields.(6)

1.2.03 Research Councils

The Research councils that have been approved and or established since 1970 include those for Agriculture, Industry, Medicine and the Natural (Experimental) Sciences. One hopes that the Federal Government would approve the establishments of both the Environmental and Social Sciences Research Councils of Nigeria whenever they are proposed - which is being advocated here. The functions of each research council are as follows:

Agricultural Research Council of Nigeria (ARCN)(7)

The Council was created to co-ordinate agricultural research in Nigeria and to intensify the application of the results of research in agricultural production. In order to discharge these functions the ARCN is expected to have control over all government research establishments and to co-ordinate the activities of all agricultural research institutes.

Industrial Research Council of Nigeria (IRCN)(8)

The IRCN which was established by Decree No.33 of 1971 is primarily required to:

(i) determine research needs which will accelerate industrial development in the nation

(ii) examine how the existing industrial research establishments are responding to these needs

(iii)Promote and co-ordinate all industrial (research) activities.

As of now, the establishments which carry out research of industrial nature include:

(a) Federal Institute of Industrial Research, Oshodi

(b) Nigerian Stored Products Research Institute, Yaba

(c) African Timber and Plywood Research, Sapele

(d) Project Development Agency (PRODA), Enugu

(e) University Faculties of Engineering and Technology.

Medical Research Council of Nigeria (MRCN)(9)

The MRCN is expected to:

(i) determine priorities for medical research and training in Nigeria.

(ii) determine how the research needs can be met, in particular the establishments of medical research institutes.

(iii) to promote and co-ordinate medical research activities in the nation.

Natural Sciences Research Council of Nigeria (NSRCN)(10)

The primary function of the NSRCN is to encourage the development of the basic skills of scientific research through support for research and postgraduate training in the Natural Sciences and to co-ordinate these activities in the Federation. As of now, there are no research institutes in the country in the natural sciences which comprise physics, chemistry, mathematics, the Biosciences and Geosciences. It is only the Universities that carry out research in the natural sciences.

1.2.04 Working Committees:

In the furtherance of the promotion of Science and Technology, the following working committees were set up under the aegis of the Nigerian Council for Science and Technology:(11)

(a) Committee on the Budget for Science

(b) Committee on Scientific and Technological Manpower and Science Education.

(c) Committee on Major Research projects

(d) Committee on Transfer of Science and Technology into industry

(e) Committee on Scientific survey, statistics and Documentation.

These working committes conduct detailed research in their respective fields and make recommendations to the NCST in their reports. The NCST in turn would consider the reports and make appropriate recommendations to the Federal Government.

All the committees are very important but one considers that on Scientific and technological Manpower of fundamental importance because the question of the requisite manpower is crucial. The training or the turn out of Nigerians of very high skill still lags behind our needs. This can be clearly seen from the statistics given in tables 1 - 8 (Appendix) in the Appendix. So far Nigeria's performance in scientific research leaves very much to be desired. The schemes for higher degrees in the country need very serious review and envouragement. Certainly the fraction of graduates who go in for postgraduate studies (Table 7) (Appendix) is shameful for this country. Though the situation must have changed since 1971 when the surveys for the statistics were carried out, the present situation, by proportion is no better. We would reach nowhere if things remain as they have been.

1.2.05 Other measures aimed at contributing to the promotion of Science and Technology in the Federation include:

(a) Establishment of Scientific Information Centres[12]

to be responsible for the collection and dissemination of scientific data, literature, and information including results of scientific research done locally and externally. Such centres will be opened to the public.

(b) Establishment of National Science Museums

to popularize science and to educate the community at large, helping to orientate the public towards science and Technology and to increase their general awareness and acceptance of its values.

(c) Organisation of Seminars, Symposia and Conferences

to give an opportunity for exchange of views between scientists, technologists, industrialists, businessmen, administrators and managers on social and economic problems requiring scientific and technological solutions and the proper role which Science and Technology can play in National development and self-reliance.

(d) Formation of Science Organisations

at all levels in the Federation are encouraged and supported by the NCST as a way of aiding individual and group initiatives in scientific research and development.

1.2.06 It is hoped that "Science Policy" in Nigeria will extend beyond paper co-ordination of scientific research and would provide a means in fact the means - of transforming Nigeria into a "developed nation" taking a respectable postion in the comity of nations in as short a period of time as possible.

Scientific research in Nigeria should of necessity be largely oriented and dictated by present needs and problems of real relevance, importance and peculiar to her social, political and economic conditions. At the same time, however, one would warn strongly against myppic planning of research programmes tailored to meet our present needs alone. Our scientific research programmes should be schemed to take care of imaginary and speculative problems and should be flexibly futuristic, capable of expanding and being adapted for all purposes.

The task of applying Science and Technology to development cannot be done by our scientists working by themselves in their separate special areas. What is being advocated for by experts is a necessary integrated and interdisciplinary approach to the problem. Nigeria[n] scientists and technologists should be challenged and confronted in such a way that there could be no question of inadequate funds and facilities. They should be encouraged to acquire self-confidence which will usher in a greator sense of psychological independence and national self-reliance.

Footnotes

(1) Nigerian Council for Science and Technology (NCST) 2nd Annual Report, Lagos, Federal Government Printer, 1971 P.6

(2) Science Association of Nigeria, The Directory of Scientific Research in Nigeria, Vol.I, Ibadan 1968.

(3) NCST, Inaugural Brchure; Lagos, FGP, May 1970, P.5

(4) Ibid

(5) NCST, 1st Annual Report, Lagos, FGP, 1970, P.10

(6) NCST, 2nd Annual Report, Lagos FGP, 1971, P.6

(7) Ibid

(8) OP Cit P.7

(9) Ibid

(10) Op-cit P.8

(11) Op.cit P.12

(12) NCST, 1st Annual Report, 1970 P.11

PART II

GENERAL FUND/MEMTAL PROPOSALS

Chapter 1 - Concept of Research type

- The Need and type of Research being provided for .....

- Validity of proposal

Chapter 2 - Statement of Purpose

- Scope of proposed centre

-

Chapter 3 - Organisation and Operation of the Centre

Chapter 4 - Special Requirements

- Funds

- Land

- Manpower

Chapter 5 - Location of the Centre

- New Federal Territory

- Kaduna

Chapter 6 - KADUNA

- The Geographic, climate and Regional setting

CONCEPT OF RESEARCH TYPES

2.1.00 "Research" could be defindd as " the methodical, systematic, directed study of a subject which is still largely unknown ."[1] Modern research is either basic or applied. Though there is no strict division line between the two, BASIC RESEARCH, is more general - a theoretical exploration of the bases of existence undertaken solely to increase the general store of knowledge - whereas APPLIED RESEARCH includes definite projects directed towards practical application of knowledge uncovered and has a specific end.[2] " The engineering aspects of research have come to be known as development, which is the systematic use of research for the design and production of materials, devices and prototypes or for the organizing of methods, processes and systems for production"[3] "Development", therefore is the essential link between Basic and Applied Research and their industrial application - hence the chosen title of "National Centre for Scientific Research and Development" for this thesis.

2.1.01 The Need for, and the Type of Research being Provided for ...

Science and Technology are general terms embracing very wide and varied fields of knowledge. Consequently it is almost impossible to deal with all the fields at the same time except at a very elementary level. The development of Scientific and technological research in Nigeria was discussed at length in chapter 2 of Part I of this thesis, above. It was shown that for the purpose of research, national research councils have been set up under the aegis of the Nigeria Council for Science and Technology. It was further pointed out that of the four existing research councils, namely, Agricultural Research Council of Nigeria, Medical Research Council of Nigeria, Industrial Research Council of Nigeria and Natural Sciences Council of Nigeria, it is the Natural Sciences Research Council of Nigeria that has no special research institutes, whereas, one expects it to contribute to scientific research in more practical ways than/just supporting research projects in the Universities.

One sees a need for a complementary research establishment to what obtains in the Universities in the development of Science and Technology. In this regard, in order not to duplicate what exists in the Faculties of Science and Engineering in our Universities, the contemporary school of thought advocating an interdisciplinary approach to scientific and technological research and development would be encouraged and supported.

Furthermore, one sees a need for a practical autonomous establishment to co-ordinate and document scientific research works and to popularize research results to useful advantage. One would also like to point out the need to provide the challenging opportunity for talented and interested Nigerian scientists at home (and those abroad due to lack of such opportunities) to make their contribution to scientific knowledge and national development.

In view of the fact that the development of Science and Technology is a crucial aspect of our national development and advancement, and in view of the need for provisions to be made for sustained scientific research and the fact that no such establishments exist in Nigeria today, it is being proposed here that an interdisciplinary research centre be planned for, designed and set up to cater for fundamental research and development in some basic and related Applied Sciences. - This is the Theme of this Design Thesis.

2.1.C2 Validity and Official Government Views of Porposal.

The idea and proposal for the type of research centre made above have been ratified as valid and relevant to the development needs of the nation by the authorities of the Nigerian Council for Science and Technology, Cabinet Office, Lagos, during my private consultations with the Principal Scientific Secretary to the NCST. Suffice to mention that the Federal Military Government has allocated for study under the auspices of the Nigerian Council for Science and Technology, the Feasibility of "an inter-disciplinary research centre consisting of laboratories, workshops, supporting services, ... to be established for long-range fundamental and applied research in areas relevant to national development not covered by existing research institution " in this Third National Development Plan period. (4)

Footnotes:

(1) Dober, R.P., Campus Planning, New York, Reinhold Pub. Corp. 1965 P.95

(2) Munce, J.F. Laboratory Planning, London, Butterworth & Co. Publishers Ltd. 1962 P.91

(3) Dober, R.P. Campus Planning, P.95

(4) Federal Republic of Nigeria, Third National Development Plan 1975 - 80, Vol. II, Project Summary, Lagos, The Central Planning Office, Federal Ministry of Economic Development, 1975, P. 428.

STATEMENT OF PURPOSE

2.2.00 As has already been discussed above, the focus of this thesis is on an interdisciplinary scientific research centre for Nigeria.
The architectural objective is to evolve the planning and design of a "National Centre for Scientific Research and Development" which will comprise a complex of interelated offices, laboratories and other ancillary research facilities within a flexible, adaptible and conducive architectural setting and environment; with an architecture that is functional based on Nigerian experience and environment; mindful of the role of scientific research in the advancement of the frontiers of knowledge and making every effort to visually potray that role.

2.2.01 The Thesis title "NATIONAL CENTRE FOR SCIENTIFIC RESEARCH AND DEVELOPMENT" (NCSRD) is derived from the functions of the research centre, namely, to contribute to national development through interdisciplinary scientific research by providing facilties for basic and applied scientific research within the centre, so that the results from the former can be used by the latter and vice versa, to respectively develope and adapt research findings and universally available knowledge to meet our national development needs.

2.2.02 Scope of the Proposed "National Centre for Scientific Research and Development" (NCSRD)

- The NCSRD is being proposed to be a centre for some basic, fundamental, exploratory and applied research and development in Science and Technology in the areas hitherto untouched by existing research establishments. Areas such as the agricultural, agroindustrial, and medicinal sciences already have some research establishments to their credit, and it is hoped that a lot would be done to make use of these facilties for their respective purposes. The centre being proposed would be essentially concerned with scientific and technical research aimed at national development and building up of a national capability in Science and Technology in such fields as the issue of "Technology Adaptation", Local Materials", "Physical and Chemical standards and Properties of Elements, compounds and Laws of Nature as may be disconvered more associated with our location on this planet.

Other areas for such pilot research work include the problems of "Energy" and "Alternative Energy" as well as any other areas deemed appropriate by the research teams. The centre would also comprise an ecological control research section to take care of the ecological implications of any development .

Organizationallly the NCSRD would be under a Director with two Deputy Directors, Heads of Sections and supported by a combination of scientific and non-scientific staff. The centre being of an interdisciplinary nature is not under any Research Councils but directly responsible to the Nigerian Council for Science and Technology and to the Federal Government through the NCST. The centre will be guided by the policies of the Nigerian Council for Science and Technology. The centre would maintain dynamic relationships with other national and international research establishments and universities, as detailed below under "Functions of the NCSRD".

2,2,03 FUNTIONS OF THE NCSRD

The functions of the "National Centre for Scientific Research and Development" include the following and any others as may be found necessary.

Research - The NCSRD will undertake and pilot research in the fields listed above and promote scienctific research in the country by way of assisting other research establishments.

Scientific Information - The centre will embark on the monitoring and documentation of scientific research results, general scientific information within and without the country with the aim of popularizing and pulicising Science and Technology and making available all the useful aspects of it.

Co-Ordination - The centre will serve as a co-ordinating nucleus for scientific research it may establish in stateline institutes or sponsor in the national universities.

Co-Operation - Nationally, the centre will co-operate and carry out research on consultancy basis for governments, universities, and other research institutes. The centre would have very strong connections with the proposed Government Metallurgical Laboratory at Jos; the Nigerian Standards Organisation of the Federal Ministry of Industries; the proposed Nuclear Research centre, Ife University; all the National Research Councils

especially the "Natural Sciences Research Council of Nigeria", and the "Industrial Research Council of Nigeria, because of its inter-disciplinary posture.

Internationally, the centre will co-operate with similar organisations (if any) in the ECOWAS member States, the O.A.U. Scientific Research Committee, similar and willing research establishments anywhere in the world.

Coferences - 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.

ORGANISATION AND OPERATION OF THE CENTRE

2.3.00 As earlier mentioned in the text, the proposed centre will be under a Director through whom the centre is ultimately responsible to the Federal Government through the Nigerian Council for Science and Technology. Under the Director and his two deputies (one in charge of "Research matters", the other to be in charge of "Other matters") is a hierarchy of Heads of Sections and their supporting departments. 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 interationship is more crucial in the Research departments as essentially, all the scientific and technological research staffs are "fluid". The method of research being advocated and encouraged is the "project method of attacking research problems".(1) This method requires the efforts of individuals having many kinds of specialized training in order to focus on the particular research job at the particular time, the required physical, chemical, metallurgical or any other specialized knowledge. If the research staff is large, it will be possible to take on many research projects at the same time by simply assigning a "project team" to each research job. Each research job or project will be tackled by a multi-disciplinary team headed by specialists in the fields to which the research essentially belong. Flexibility in personnel assignments is therefore necessary and provisions must be made to facilitate it. The technicians, expecially of the junior and intermediate ranks and the clerical staff attached to research departments shall, however, remain essentially non-fluid.

2.3.01 Architectural Implications of Organisational Structure

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

Footnotes: (1) Architectural Record, Buildings for Research, F.W. Dodge Corp. 1958. P. 3

THREE SPECIAL REQUIREMENTS

2.4.00 One identifies three rather basic and special requirements for the establishment of a progressive scientific research centre: They are the Funds, Land and Manpower.

2.4.01 The "Funds Requirement" is very crucial because other requirements are in one way as the other related if not dependent on it. By the very nature, scope and magnitude of the research centre being proposed, the question of funds rests squarely on the Federal Government for the nation. Given our present economic potential and the overiding need for the urgent establishment of such a research centre, it is being assumed that the financing would not be a problem (The proposal is anyway a hypothetical one).

2.4.02 The requirement for land is so much and unpredictable that the siting of the research centre must be chosen to be within a land use zone where future expansion is very possible and where hazards of atmospheric polution, noise and vibrations are either non-existent or minimal. This factor is considered in detail later on. Acquiring enough and suitable land anywhere in the country should not be a problem, in view of its importance to the nation.

2.4.03 Very high quality and specialized manpower is required for the type of research centre being proposed. The shortage of such high calibre manpower is common knowledge, moreso as the staff composition should be overwhelmingly Nigerian, in view of the main idea of self-reliance. The shortage of high level and educated Nigerians will become more acute as a result of the phenomenal expansion in our universities.

The problem of high calibre manpower can only be solved by concerted efforts by the Government and institutions of higher learning to encourage and support talented, able and interested Nigerians to pursue postgraduate and post-doctoral studies. As of now the proportion of higher degree graduates and students to that of the undergraduates is virtually insignificant. There is a serious need for a review of our postgraduate schemes with a view to improve on the present alarming "go-slow".

In addition to aiding new higher degree students, genuine efforts should be made by the Federal Government to persuade thousands of highly qualified Nigerians which are scattered all over the world to come over to their motherland and help us. One believes that world-wide but covert publicity to Nigerians about the challenges of establishing a meaningful and strategic research centre would convice many to come home. All Nigerians must honestly contribute to evolve a stable political system for the country as this has been one of the crucial factor keeping many serious , peace loving and highly qualified Nigerians abroad.

All said and done, it is the spirit, dedication and honesty of our scientists that will enable them to find the "Truth" we are striving for.

(see Appendix tables 1 - 8)

LOCATION OF THE CENTRE

2.5.00 National consideration:

By the nature and scope of the centre being proposed which is directly reponsible to the Nigerian Council for Science and Technology (NCST) and ultimately responsible and accountable to the Federal Government, location must be carefully considered in the interest of the nation. As a matter of requirement, the NCST Headquarters must be in the Federal capital and in close relationship to the seat of Government.

Ideally, the centre being proposed should be as close as practicable to the headquarters of the NCST for communications and if need be inspectorate purposes. Practically, the centre requires a quiet, noise-free, vibration-free, polution-free and land readily available for substantial expansion area. A peripheral area within the Federal Territory which is free of industrial developments and satisfies all the requirements mentioned above would be very appropriate.

At the time of the studies for this thesis, Lagos was the pro-ten Federal capital as the issue of the New Federal Territory had just been settled. The Federal Territory of Nigeria is an 8,000 square kilometre area in the central part of the country to the south of Abuja town in Niger State.

This means that the headquarters of the NCST (which have not yet been built) would eventually be built in the new Federal capital, and within easy reach of it should be located the research centre being proposed.

2.5.01 The Federal Territory is the first choice and most suitable site in view of its scope, function and ultimate responsibility to the Federal Government. However, the main problem in the way of siting the centre at the Federal Territory is the lack of a planned and zoned land use map (as at February 1976).

2.5.02 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 propsals. Factors to be considered in the selection of the alternative site include the following:

(i) how close the area is, in terms of amenities, services, utilities and available manpower, to that expected of the Federal Territory;

(ii) how close the area is, in terms of distance, to the Federal Territory which if reasonably not too far could in fact be ultimately a location very suitable for the purposes expected;

(iii) how close the area is to the Federal Territory, in terms of and in the light of some of the considerations for the selection of the location of the new Federal Territory, namely "centrality, good and tolerable climate, land availability and use, adequate water supply , ---------- physical planning convinience, 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;

(iv) any other factor to the credit of the area under consideration.

2.5.03 Analysis of possible locations:

Each of the four criteria for selecting a feasible location for the proposed centre will be considered in turn.

(i) In considering "how close the area is to the Federal Tebritory, in terms of amenities, services, utilities and available manpower" one immediately thinks of possible urban areas of the country. The major urban areas in the country include the "acting" Federal capital of Lagos and some state capitals like Ikoja, Ibadan, Kaduna, Kano, Enugu, Jos, and Port-Harcourt. These eight urban areas could be considered in terms of the facilities they hage. However, rather than debate much on them, the other factors would be taken into consideration in order to further reduce the number of urban areas for analysis.

(ii) In considering "how close the area is to the Federal Territory in terms of distance, one finds out that

Kaduna and Jos are the nearest with Kaduna being a little bit closer than Jos as the crow flies. Kaduna has another advantage of being currently linked by a National Highway under construction from Warri in Bendel State, through Benin, the proposed "Steel City" and Lokoja in Kwara State, and through the Federal Territory.

(iii) In considering "how close the area is to the Federal Territory in terms of the considerations for the location of same, namely "centrality, good and tolerable climate, land availability and use, adequate water supply ..... physical planning convinence, security and multiaccess possibility ....." one finds that though Jos reputedly has a good and tolerable climate, Kaduna excels more in terms of the other factors of centrality, land availability, physical planning convinience and multiaccess possibility. That explains why Kaduna was one of the four major areas including the present Federal Territory that viewed for the siting of the Federal Territory. It is of significance too to point out that Kaduna along with Lagos and Portharcourt have a "Federal Status" being designated by the Federal Government as Federal "Speical Areas". Of all the Federal special Areas, Kaduna is the nearest to the Federal Territory and one would expect many Federal Government establishments to be located in the nearby Federal Area of Kaduna.

(iv) Other points to the credit of Kaduna are: good road, rail and air links with all parts of the country, its "central" location with respect to all the existing and proposed universities. Kaduna, being a non-university town has the possible advantage of being neutral and unbiased in any inter-university politics. With the siting of an Oil refinery in Kaduna, there adds a new possibility of direct and cheap supply of natural gas to be used in the research laboratories.

In view of the above arguments in favour of locating the proposed "National Centre for Scientific Research and Development" in Kaduna in lieu of planning maps for the Federal Territory, it is being submitted that Kaduna area would be used for the physical planning and siting of the proposed centre of this thesis.

Footnotes

The maps shown were "culled" from one of the National dailies - the "New Nigerian".

THE GEOGRPHIC, CLIMATIC AND REGIONAL SETTING

2.6.00 Kaduna, the capital of Kaduna State is situated within the northerly Guinea Savannah vegetational zone of Nigeria, approximately at lattitude 9° 30" N and longitude 7° 30" E.

Kaduna came into existence in 1912 when it was located by Lord Lugard as the most strategic place for his colonial administrative and military headquaters for the then new protectorate of Northern Nigeria(1) Kaduna continued as the capital of the Northern Region of Nigeria during the colonial and the first six years of post-colonial Nigeria. It became the capital of what is now known as Kaduna State (being earlier called "North Central State") in 1967. In February 1976 it was given a new status as a "Special Area" of the Federation by the Federal Government.

Kaduna is not only an important political and administrative city in Nigeria but has steadily grown into an important military, transportation, communications and industrial centre with a population of well over 200, 000 people from my conservative estimate.

2.6.01 Topography and Geology:

Kaduna's regional topography consists of a rolling park-like terrain with little relief situated about 30.5m above and below the 61.0m (200') contour line. The whole area is crossed by mature wooded streams flowing in broad shallow valleys.(2)

The basic geological structure is magnatic of mixed streaky rocks, granite in parts with darker softer bands and much varied. The water table in Kaduna is usually quite high, meaning that comparatively, wells are sunk to a shallow bore of less than 16 metres.(3)

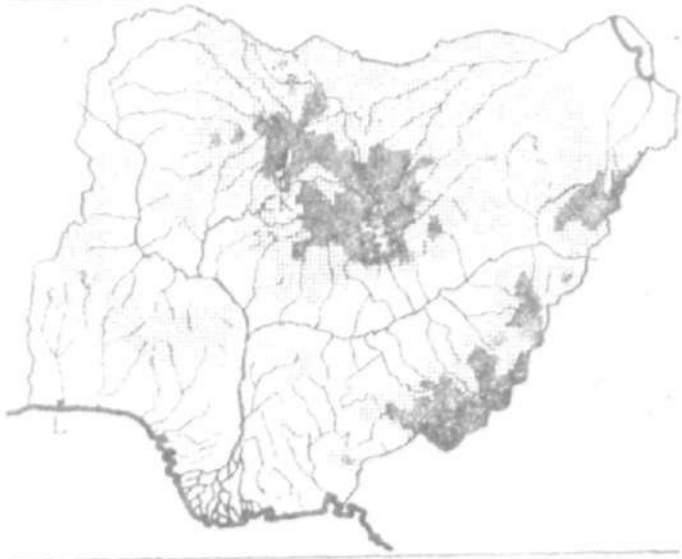
2.6.02 Climate, Rainfall and Wind:

The prevailing winds during the dry season from November to March are the dry, cold and after strong, dust laden Harmattan winds which blow from the North-East straight from the Sahara desert regions. The prevailing winds during the rainy season from April to October are the South-West Trades.

ECOLOGY Figure 5



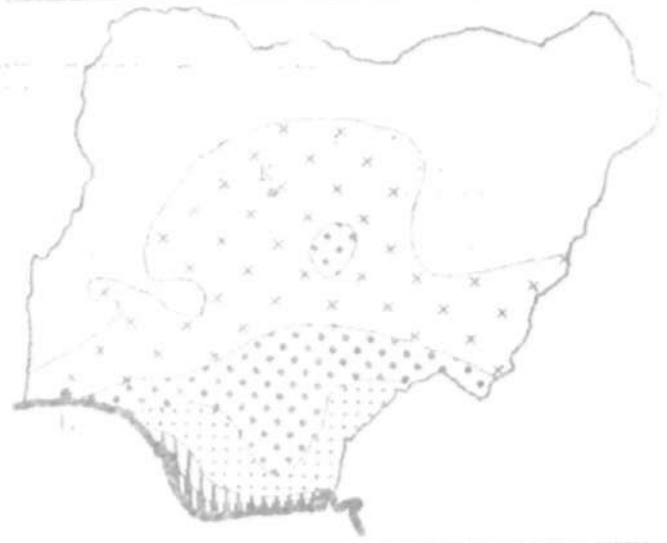
RELIEF & DRAINAGE Fig. 7



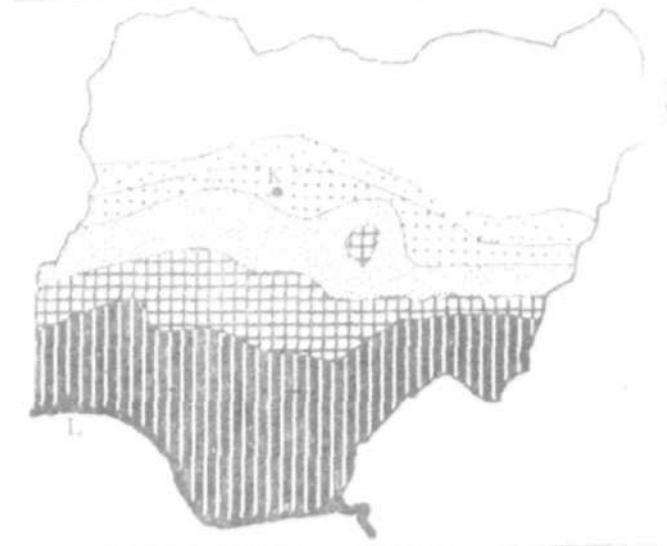
VEGETATION ZONES Fig. 8



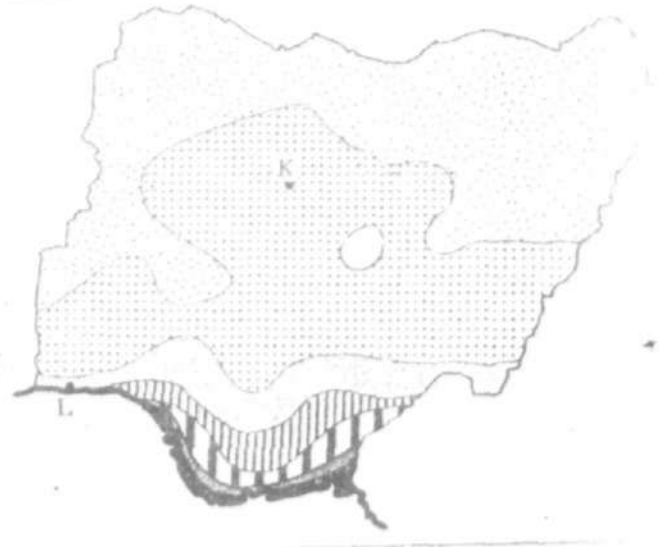
WET SEASON RAINFALL
April-October inclusive Fig. 9



MONTHS WITHOUT RAIN Fig. 10



TOTAL ANNUAL RAINFALL Fig. 11



It must be noted, however, that the rain storms which are usually violent with thunder and highligh and preceded by a driving wind, come from the North-East; and it is from this quarter that man needs the most protection all the year round- climateically speaking.(4)

2.6.03 Temperature

Generally, the highest temperatures are in March/April and range between 35°C and 40.6°C while the lowest are in December/January and range between 7.2°C and 12.8°C.

The relative humudity during the dry season may be well below 10 percent in the afternoon and 30 per cent at dawn. This causes the skin and lip to crack while the fine dust blown by the Harmatten aggravates the nasal passages. By mid rainy season in August, the relative humidity at midday can be over 70 per cent and at dawn 95 per cent .(5)

The climate of Kaduna can be described as moderate without the extremes of the "sub-saharan" zones further north and the rainforest zone of the south.

Footnotes

(1) Max Lock and Patners, KADUNA, London, Faber and Faber Limited, 1967. P. 18

(2) Op. cit. P. 20

(3) i bid

(4) ibid

(5) op. cit P.21

* The maps shown were taken from the max lock Report on Kaduna.

PART III

RELATED STUDIES

Chapter 1 - General and Ancillary Facilties

- Administrative Offices
- Library
- Publication Unit
- Television Unit
- Computer Unit
- Service Facilites

Chapter 2. - Laboratory Planning

- Types of Research laboratories
- General Laboratory space
- Unit of Laboratory space
- Rooms associated with laboratory space
- Laboratory services
- Special laboratory Planning problems
- Layout of Laboratory Building
- Design of Laboratory Buildings
- Laboratory Fittings

Chapter 3 - Site planning studies

GENERAL AND ANCILLARY FACILITIES

3.1.00 There are four basic areas in any Research centre (Laboratory complex)(1)

(i) the area for Research itself

(ii) the administrative offices and facilities

(iii) the general support facilities such as auditorium and cafteria

(iv) service facilties such as workshops and boiler plants.

The addtion of teaching requirements does not change this pattern significantly. One main problem one must guard against especially with the non-research facilties is to prevent them from interfering with the design of the research areas. For example, a badly located auditorium or boiler plant can strangle expension and interfere with efficient expansion of the research areas.

The most comprehensive way of avoiding such difficulties is the overall planning grid. A master plan must make provision for the expansion of each of all the four basic elements that make up a Research centre either through campus type of development or through sufficient articulation and separation of each area.

All the four basic elements except the "Research area" will be treated in this chapter. The "Research area" will be exclusively treated in the next chapter, in view of its importance.

3.1.01 The Administrative Offices:

In the administrative offices of the Research Centre, as in any administrative set up of offices, the space required per employee will depend on type of work -- in terms of rank; use of equipment or machinery degree of privacy; and storage needs.

Generally, the office of the chief executive should be "executive" with enough allowance for small committee meetings. High ranking administrative officers should have separate offices, whereas other administrative personnel may share offices.

3.1.02 Some of the most important supporting facilties to the effective functioning of any research establishment include the Library, the Computer Unit, the Publication (or Press) Unit , museum/exhibition facilities for public information, a conference complex for both internal and external participation, and a closed circuit television system.

Some basic undstanding of the function of each facility will go a long way in aiding the effecient planning of the research complex.

3.1.03 The Library

It is common knowledge how important the Library is to any institution . As much as practicable the library facilties should be within easy reach of the users - notably those engaged in research work. To effect a greater degree of proximity to research area, sectional libraries could be organized, so that the central library could cater for more general aspects and stock rare collections and government documents as well as journals.

The categories of users of the library include the research staff, its own staff and perhaps a controlled number of outsiders who may be allowed to use the library for reference purposes.

The activities that take place and need to be catered for in the library include:

- making references to books and journals
- general reading
- study and "paper writing"
- information retrieving
- library administration
- library books and periodicals mending and binding
- shipping and receiving of books.

Generally the facilities to be provided to cater for the catalogue of activities listed above can be grouped under four sections:

(1) The introduction to the library building, which consists of the following:

. the vesibule

. lobby and control point

. circulation services

. reference facilties

. periodical indexes

. card catalogue

. browsing facilties - if any.

(2) Technical processes and administration which consists of

. receiving and shipping rooms

. technical processes

- order department

- cataloguing

- mending, binding, serials and government document processing

- administrative offices.

(3) Books and Readers which consists of.

. the books stacks

. reading facilities - tables and carrels

. special collections

. bibliography

. micro-reproduction facilities

. audio - visual facilities - if need be

. seminar facilities - if need be

(4) Miscellaneous facilities may include

. auditoria if need be

. staff rooms

. smoking rooms or lounge

. typing room

. toilets

. Fire exits etc.

The "library keys" are those tools and services that serve as keys to the library and should be visible immediately beyond the lobby. These include the information desk, the circulation desk, the card catalogue, index and reference services (bibliography) etc.

One is of the opinion that for new research establishment, and any high instituion of learning for that matter, the library should be so designed to be as big as possible in order to comfortably contain the continuous increase in total volume of books and periodicals for at least two decades.

Generally science collections double about once in a decade and in determining the amount of space required for stack space the number of volumes has to be translated into "square footage" estimate. As a rule of thumb, by dividing the total number of volumes to be accommodated at the end of the planning period by the factor of ten, the resulting figure is approximately the number of square footage required for shelving the collection .(2)

According to Dr. Ralph E. Ellsworth in his book "Planning the College and University Library Building", the shape of the book stacks will affect the calculations mentioned above. For a long narrow room will yield fewer square feet of space per unit than a square one.(3)

Summary for book space:

According to Ellsworth -

(i) to allow space for carrells around the edges of a stack floor -- and for doubling the overall collection use ten volumes per square foot.

(ii) Five volumes per linear foot (per 3000 mm) will allow enough working space for nearly doubling the size of the collection i.e. at the beginning the shelves will be half full.

(iii) There are many ways of arranging the stacks within an area but one mistake to avoid is to force readers to walk across a reading area to get at the stacks.

Generally, the reading space could be within or adjacent to the book stacks. For general university libraries an "open stack system" is adequate for undergraduates, whereas the graduate students a "closed stack system" with carells to avoid the rather noisy open stack system. In a research establishment where virtually all the users are graduates and researches, the use of study carrells are imperative.

If possible these carrells should be sound proof enough to allow the use of a typewriter. Sometimes the carrells are desired to be large enough to enable the scholar to work with his secretary.

The amount of space needed for services varies with the kinds of activities the library will support. Certain basic functions common to all libraries, however, are:

- Circulation control and processing
- reproduction equipment
- cataloguing and processing facilities
- storage and wash room facilities.

To determine a reasonable planning figure add the reading space and bookspace and multiply by twenty percent. This resulting figure will give an approximate total square footage requirement for service space for planning period covered in the projection.(4)

.1.04 Publication Unit

The need for a publication or Press unit to any research establishment rarely needs to be emphasized . Some of the advantages of such a unit include the reduced communication gap between the authors and publishers; reduced expenses on publications especially as commercial publishing costs are unpredictable and on the upward trend. The facilities to be provided may combine printing and publishing functions.

Space requirements include offices for administration, editorial and graphic design; dark room, spaces for the production plants and storage. "One storeyed buildings are prefered in order to allow continuous manufacuting flow platterns" (5)

.105 Closed-circuit Television Unit

An important factor in the efficient and sucessful operation of any research centre is the ease of communication and quick transfer of information to all component sections. A closed - circuit television network within the research establishment will aid and promote the quick transfer of information. With a television systen it will be possible for information to be relayed to as many parts of the centre as have television receiving sets at the same time.

It would be possible for panel discussions or special laboratory procedures or reports on remote and off-the-centre activities to be relayed to all parts of the centre at the same time. The scope of use of a closed-circuit television network as a facility for aiding research work is flexible and could be adapted for any purpose.

Generally in institutions where closed circuit television facilities are used the installations are simple. At Pennsylvania State University in America , for example, the installation consisted of one studio with two "vidicon" cameras, a professional control room as well as slide film projectors.(5)

In a report on closed circuit television in Granada Universities it was suggested that a reasonable studio size could be about 32' by 34' (9.7m x 10.3m), the list of apparatus include cameras, vision mixing equipment, microphones, televine, videotape sound equipment and monitors. It was also suggested that three cameras are ideal while the staff include:

- cameramen - one for each camera
- camera control operator
- sound level and lighting controllers

maintenance engineers

- programme director/producer
- graphics artists
- clerical assistants

The Studio is the heart of original programmed television and is the room where television cameras are used. ( ) Studios range in size from that of a regular office to large studios and variety programming. Interior acoustical requirements depend on the type of programming and in any case the studio must be insulated against outside noise and isolated from vibrations that could be felt by sensitive cameras. Studios should be located to avoid heavy outside traffic and vibrations due to heavy machinery.

The Control Room contains electronic equipment for monitoring and controlling the studio output. It may have separate apartments for sound (studio) picture (video) and lighting control. Control rooms must easily be accessible to the studio which they serve.

3.1.06 Computer Unit(9)

The National Office Management Association of the United States of America defines a computer as "a device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes ..... from internally stored instructions ....."

The use of computers for solving scientific and engineering problems and calculations are well known. In the fields of scientific research, the computer is a time saving ally and daily new prospects for its use are being figured out.

The categories of users include the curious "public" who may visit the location; the administrative staff who may use it for accounting purposes; the research personnel who will need the computer services for their research; finally the most direct category of users are the computer operational staff whose duty it is to control the running of the machines.

The categories of activities that take place at the computer unit bear direct relationships to the categories of users. Consequently the casual visitor goes there for viewing and if possible be briefed; the staff members of the institution submit programmes to be run and to get their results; while the computer staff do the operation of machinery, and undertake studying and problem solving. The running of the programme is usually in two parts, namely the preliminary or "check" running and the main computer operation.

The facilities to be provided are to meet the needs of the activities outlined above. The facilities include:

- the administrative offices for officers
- and clerical assistants;
- "Ready Room" or preparation room where programmes are submitted and results collected.
- Key punch rooms(s)
- auxillary equipment room for preliminary or check running of programmes
- viewing space for casual visitors
- main computer room
- machines room
- storage spaces.

- maintenance engineers' office.
- library, seminar room etc may be provided.

Computer Special requirements

Factors that require adequate and special consideration right from the planning stage are:

(i) The choice of computer system and therefore the adequate space it requires for its installation with adjacent space for maintenance engineers.

(ii) Provision of adequate spaces for auxillary mechanical equipment for the computer.

(iii) Floor strength and construction: Units which compose the computer system (Electronic Data Processing) are heavy giving rise to high point loads at some points. The methods of solving the load distribution problem is by provision of a secondary floor raised over the building floor slab . This raised floor system has other important advantages, namely interconnecting power cables and receptacles can be concealed and yet remain readily accessible while the space between the floors can be used to house air conditioning ducts.

(iv) Air-conditioning - The provision of adequate air-conditioning is necessary because computer/ require very close control of air temperature, humidity and dust. Failure to provide the right environment may cause the system to stop working.

(v) Some units of the computer system, for example the card and printing machine, produce considerable noise. For the comfort of system operators, accoustical treatment of the area is desirable.

(vi) The systems manufacturers usually recommend minimum average illumination of about 40 foot- candles measured about 75 cm above the flor level. Low levels of illumination are required for easy observation of various console and signal lights. Direct sunlight should therefore be avoided.

(vii) Generally computer systems should not be installed in an area that is subject to large amount of vibration.

(viii) Electric Power

Computer systems place heavy loads on the electrical system of any building. Care should be taken to ensure that the computer system feeder should feed no loads other those for the system. (9) The system should be adequately protected from Lightning.

3.1.07 Services, Maintenance and Plants Operations

These functions require such spaces asutility (or services) plants, incinerators, repair yards and workshops, garages, storage rooms, locker rooms, and administrative offices for the supervision and keeping of records for those activities.

Where the maintenance personnel prepare plans for Campus construction, drawing studios and conference rooms will be included as part of the facility.

Typically, the security guards and fire station areunder this department.

A peri pheral site for this department is justified on the basis of vehicular mobility. Work crews may be supervised and controlled through intra-campus communication systems. A good access to major campus roads is a desirable and necessary requisite for site location (10)

Footnotes

(1) Chiara, J. & Co. Time Saver Standards, Building Type P. 866

(2) Dober, R.P., Campus Planning, N.Y. Reinhold Corp, 1964, P.91

(3) Ellsworth, R.E. Planning the College and University Library Building, Cdorado, Prvett Press inc. 1962. P. 65

(4) Dober, R.P., Campus Planning 1964, P. 91

(5) Op. cit, P.117

(6) Cassier, H.R., Television Teaching Today, Paris, UNESCO Pub. 1962.

(7) Granada University, Television in the Universities, a report of a Granada Seminar ——— Granada TV. Ltd 1965 P.69

(8) Chiara J., Time Saver Standards Building Types P. 717

(9) Op. cit.

(10) Dober, R.P., Campus Planning, 1964, P.115

LABORATORY PLANNING

3.2.00 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 scientific 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 hundred scientists.

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

(c) Services laboratories primarily designed for the control and testing of products and conditions, working to a set 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.

3.2.01 Types of Research Laboratory

Broadly speaking, there are two main types of research laboratory: The bench and the fixed plant laboratory types. Within both spheres the aims of the particular research will involve diversity in design. The individual dictates the architectural scale of the building for the bench type unit, as it serves the person rather than the plant, so do its room heights, areas, orientation, lighting, heating, ventilation and services which relate to the requirements of the individual together with his apparatus, balances etc. The bench type laboratory could be referred to as the "general research laboratory".

In contrast to the bench type laboratory the fixed plant laboratory , on a greater design scale is resolved and even dictated by the machinery. In some aspects, such as finishes, machinery is not so demanding as men, but in some other aspects it can be more so. "As well as determining the extent, form and scale of its spatial envelope, the plant service

routings, constant temperature levels and accuracy of building construction are greater than those needed in bench laboratories."(1) The fixed plant type could be referred to as "workshop or technical laboratory".

3.2.02 Workshop or Technical Research Laboratory

There are varying types of laboratories that could be grouped under the workshop (or technical or heavy) laboratory. These include laboratories for testing materials in industries, military laboratories and heavy research laboratory orkshop in Engineering.

Such large and high labor tories generally house bulky equipment having special demands, and for economy and ease of service they should be located at ground level. The basic need is that for clear and uninterrupted floor space. Crwnage demands determine the height of the building and overhead travelling cranes or swivelling jibs may involve severe loading on the structural framework.(2)

In terms of building shape, early buildings were narrow because of the need for natural light. Expansion then was by extending the ends and by adding cross buildings in a rectangular fashion. With the relatively cheap artificial lighting, the emphasis is on plants that are relatively square and not "honey-combed" or obstructed by walls. Such plants are built in rectangular sections and expansion is by building additional sections to the sides or ends.(3)

3.2.03 BENCH TYPE RESEARCH LABORATORY

The research portion of the laboratory complex is itself divided into several basic elements:

- most research areas require desk space as well as bench space and many experiments require controlled environment with closely regulated temperature and humidity or the elimination of outside contamination.

Controlled environment istallations cannot be accommodated within ordinary research laboratories and require special rooms.

In addition scientistis frequently wish to have conferences (seminar) rooms directly associated with research and there are usually some fairly extensive storage requirements.

3.2.04 GENERAL LABORATORY SPACE

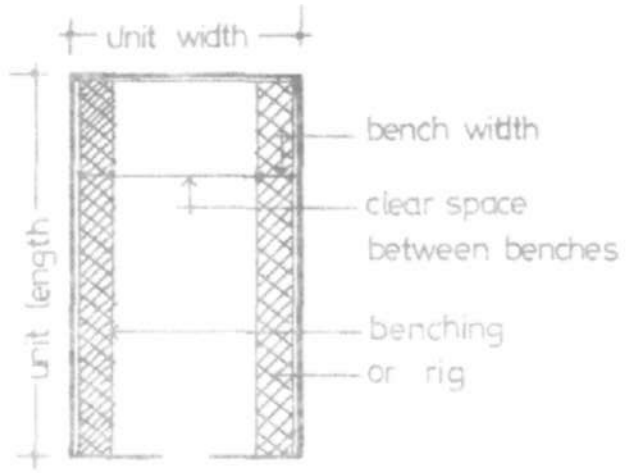
The most useful way in which to consider the size of the laboratory room is in terms of the number of workers it is to house, as this is often the only information available to the architect at the early stages of design. (It is being noted here and in parenthesis that where very large scale equipment, is in use, standards based on the equipment controls the space required in the building. For example in heavy engineering laboratories)(4)

General laboratory space may be regarded as the scientists' working base, and for the purpose of planning it forms the centre of laboratory activities. Every scientist needs this type of space except, probably those engaged exclusively in administration. The laboratory space must be adequately supplied with services and may or may not be equiped with conventional laboratory benches and fittings. Other rooms associated with the laboratory space such as controlled environment rooms, scientists offices, balances rooms and stores which are nearly always shared must of course be provided.

The floor area needed in the laboratory per individual worker is defined by two dimensions: Length and width. LENGTH is the total length of benching, sink, fume cupboards etc which the scientist needs for his 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 dimensions 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.

In working out the area per person required in research [illegible] laboratories it is reasonable to assume such standards as would be applicable to rooms designed for two or three workers (5)



A

unit providing long and straight benching proves more efficient

a building composed of such units will require less corridor space and therefore more compact and economical

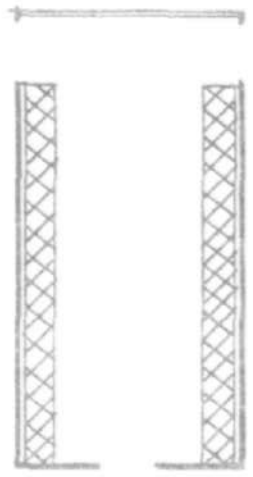


B

a square unit with benching running on three sides proves less efficient

it is more expensive to run services around three sides of a unit

it is wasteful of floor space



C

it is advisable to allow a clear space between the end of the run and the outside wall of the building in order to provide a doorway between rooms as it gives an alternative direction of escape in the event of fire or explosion etc

FIG. 12 UNITS OF LABORATORY SPACE

- Bench Length:

Straight run of benching is much more convinient and desirable for users than bench runs that go round the corner. It should be the objective of the design of any research laboratory to provide for uninterrupted runs of benching of at least 15 feet (4.6m) in length - anything less is open to question. This length excludes the linear spaces for fume cupboards, sinks, storage, reading and writing activities.(6)

- 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 the laboratory where safety is of major importance, the criterium should be to provide a bench width which allows the scientist to work in comfort but which does not encourage him to lean so far over the bench that quick recovery or retreat become impossible. From a survey carried out by the Nuffield Foundation(7) it was found that " ---------- if an allowance is made for leaning, a bench width of 24 inches (600mm) would allow comparatively easy manipulation of service taps and outlets". The nearer these services points are to shoulder height the easier they will be to operate.

- Space between benches:

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

- Space taken up by worker when actually engaged in working at the bench
- Space taken when walking parallel with and close to the bench and for emergency movement
- Space needed for bending down in front of bench, for example to take something from cupboards under the bench
- Space needed for use of trolleys carrying supplies or equipment such as portable pumps and compressors (8)
- Space needed for two persons working back to back and at least one person passing between them.

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

- 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 intended to receive effluents from experiments. Provision of drainaways is an integral part of the servicing arrangements for the working bench. Sinks for washing up and their draining - boards are additional to normal benching.
An overall length of about 5 feet (1.5m) is considered likely to meet most of the demand(9). It must be noted here that in new research establishments, washing-up is done centrally.

Fume-cupboards should be provided in every laboratory space even if rarely used, in the interest of flexibility and the health and safety of workers. They are of standardized sizes, so that appropriate length may be chosen depending on anticipated use.

5.2.05 A UNIT OF LABORATORY SPACE - THE MODULE

The limiting dimensions of a basic laboratory room will depend on: LENGTH- which is determined by the necessary run 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; WORKERS - It has been established that the most useful general purpose unit is one which will house a small group of scientific workers, perhaps two or three in number .(10)

Based on the research findings and recommendations of the Nuffield Foundation a unit of laboratory giv es an overall depth of room, from corridor to the outside wall of 24feet to 25feet (6.3m - 6.6m) shallower rooms will not provide the essential 15 feet (4.6m) run of available bench space. The same Nuffield Foundation recommended that the centre to centre dimension between runs of benching may between 10' - 6" (3.2m) and 12' - 0" (3.6m).(11)

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

3.2.06 ROOMS ASSOCIATED WITH LABORATORY SPACE:

In general terms spaces associated with research laboratories could be classified into two categories as used by the Nuffield Foundation(12)

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

Secondary space:- which include scientists' offices,
stores, staff rooms, boiler rooms,
stair lifts and coriddors, conference rooms,
sectional workshops, pilots, showers and first aid
facilities.

Offices for Scientific Staff:

A good deal of the scientists time is spent in reading and writing therefore there is a need for the provision of space for these activities. There are at least three ways of meeting that need: provision of desk in laboratory itself, or provision of a separate office ning adjoining the laboratory or provision of offices more or less remote from the laboratory. Empirical results suggest that the office space should have a measure of quiet and privacy while opening directly into the laboratory because of the need for close contact with work in progress in the laboratory.(13)

Apart from offices certain special rooms are found in close association with laboratory spaces. (In some books they are called "special rooms" while in others they are called special "service laboratories"). These include BALANCE AND INSTRUMENTS ROOMS, DARK ROOMS, CONTROLLED ENVIRONMENT ROOMS, ROOMS FOR HOUSING SPECIAL TECHNIQUES (e.g.) Chromatography etc.

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. In large establishments it may be necessary to centralise special rooms in one area, convinient for services and placed in a position which will cause as little inconvinience as possible to the users.

Balance and Instrument rooms:

Balances and such delicate instruments may be used in the general laboratory but frequently are housed in separate rooms centrally placed in relation to the laboratories that share their services free from heat and vibration sources; free from corrosive fumes; excessive humidity and dust.

Controlled Environment rooms:

Such rooms comprise those concerned with controlled temperature and /or humidity. Others include pressure or elimination of dust. Special structures and finishes are invariably required to meet the peculiar needs.

Dark-rooms:

Photographic and photometric techniques are used in almost all scientific disciplines. Dark-rooms are therefore required in most laboratory buildings. The sizes of rooms to be provided depend on the anticipated volume of photographic work.

OVERALL SPACE REQUIREMENTS

The laboratory space proper is needed at the rate of 100 sq ft ($9.29m^2$) per worker. Therefore each laboratory unit-which should be designed for a minimum of two or three people has a minimum area of 300 sq ft ($27.9m^2$).

From the research findings of the Nuffield Foundation, if 100 sq ft ($9.29m^2$) is taken as 20% of total area needed then total area needed per worker (including non-scientific staff, is about 500 sq ft (($46.45m^2$) (14)

Room height:

Based on general architectural principles of proportions and harmony, ceiling height should be related to the size of the room, the number of workers and the desirable air-changes.

Most general research laboratory units would be satisfactory if the ceiling height is between 9'-0" and 10'-0" (2.7m and 3.00m) except where the equipment needed require higher headrooms.(15)

LABORATORY SERVICES:

3.2.07 Services within a research laboratory require more emphasis than is customary with the design of other buildings. Cubic space and floor space are needed to house the heating, ventilating, and air-conditioning systems and the multiple pipes of the various laboratory services such as water, gas, vacuum, and oxygen.

To avoid redundancy, before installing more than normal "domestic" services (water, town gas, mains single-phase electricity, and drainage) it is advisable to study the actual needs of the scientific techniques likely to be practised in the building.

Some or all the piped services given below may be required to be provided.(16)

Service	Availability	(per outlet)
Cold water	25 - 50 psi (1·2-2·4 Kg/m²)	3 gal/min (0·228 litre/sec
Hot water	10 - 30 psi (0·4-1·44 Kg/m²)	1 gal/min (0·076 litre/sec
Distilled Demineralized water	2 - 30 psi (0·1-1·44 Kg/m²)	1 gal/min (0·076 litre/sec
Steam steam baths special purposes	5-15 psi (·24-·72 Kg/m²) 15 - 100 psi (·72-4·8 Kg/m²)	100lb/hr (45·4 Kg/hr) 100lb/hr (45·4 Kg/hr)
Gas (town)	above 3 in wg ( )	varied
Gases (inert) (Argon (Nitrogen	12 in wg ( )	as required
Oxygen	15 psi (·72 Kg/m²)	varied
compressed air	5 - 15 psi (·24-·72 Kg/m²)	20 ft/min (6.1 m/min)
Vacuum	10 - 15 cm Hg	
Electricity		60 A 13 A

Selection of services distribution systems:

Selection of the services distribution systems strongly influences the configuration, design and cost of a research laboratory building. As a rule, it is better for the system or systems of services distribution to be selected as early as possible in the planning process, and before the room arrangement is fixed. The room arrangement, equipment location should follow the services distribution system once the pattern is standardized. The pattern of services distribution, so laid out should practically be identical on each floor and designed to flexibly meet the capability needs of the programme that will occupy the building over its life with appropriate consideration of costs.(17)

TYPES OF SUB-MAINS DISTRIBUTION OF SERVICES
(see figures 13 – 23)

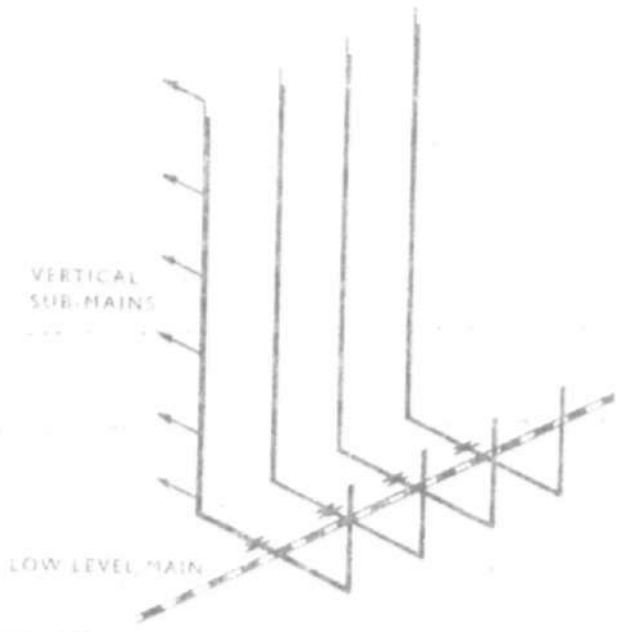


Fig. 13 Vertical sub-mains fed from a main at low level using one vertical riser for each cell.

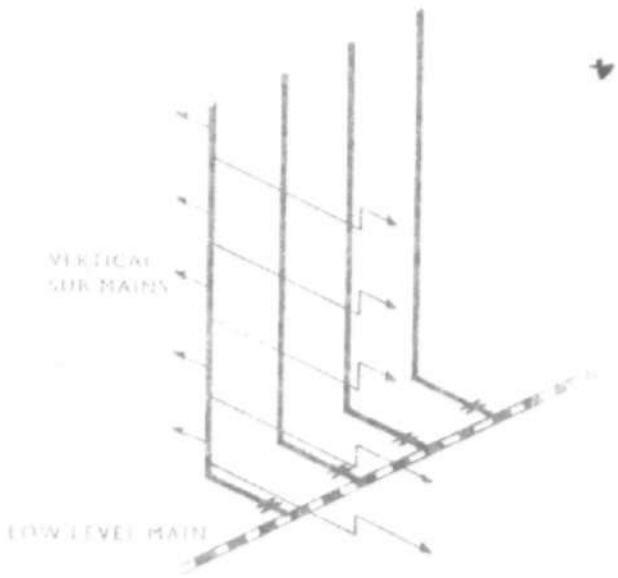


Fig. 14 Vertical sub-mains fed from a main at low level using one vertical riser for each pair of cells, on either side of the corridor.

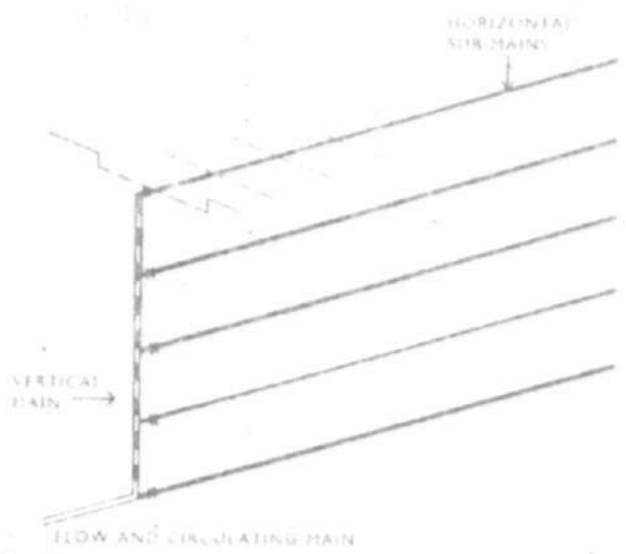


Fig. 15 Horizontal sub-mains at each floor level fed from one vertical main.

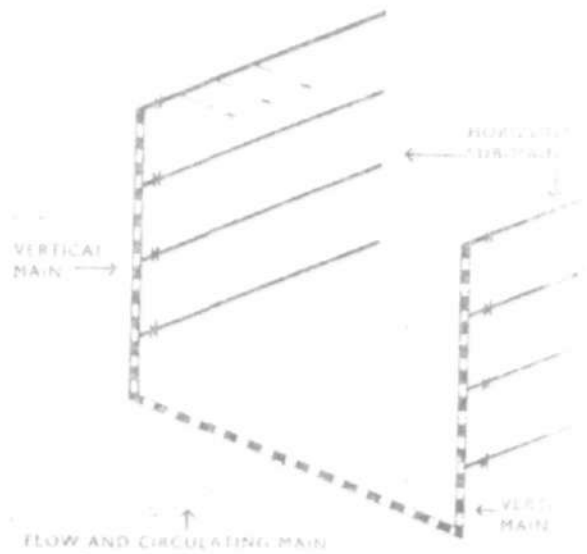


Fig. 16 Perimeter sub-mains at bench level fed from two vertical mains.

Types of Services distribution Systems:

Services are usually provided within a research laboratory building by either a horizontal or vertical distribution system or a combination of the two.

Vertical sub-mains are fed from horizontal 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.

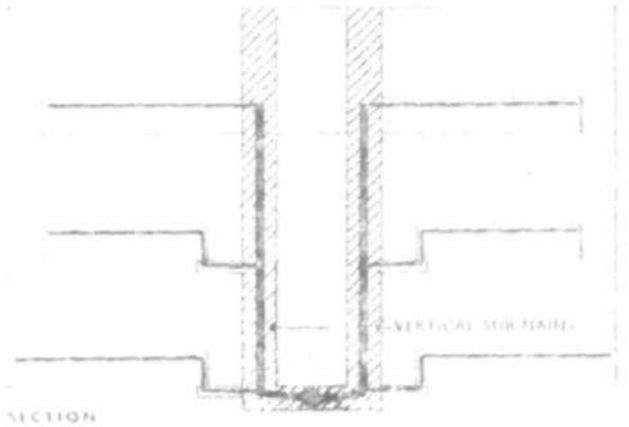
In services distribution systems using vertical sub-mains, shafts containing ducts are carried at each or alternate module, either on the coriddor wall or on the outside wall. Peninsular benches attached to either coriddor walls or outside walls respectively constitute the most economical bench layout in conjuction with this type of servicing, as the pipe lines supplying the bench points can be taken directly from the sub-mains without further structural duct work.

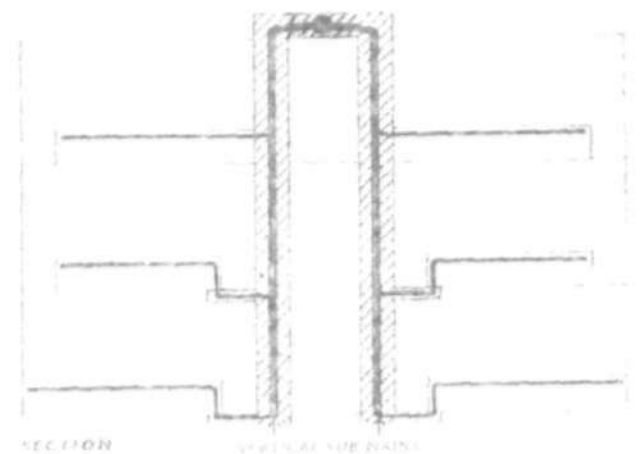
In the horizontal sub-mains systems, the horizontal sub-mains supply a number of adjacent rooms at each floor level. Pipes and cables run at high or low level in floor ducts or between the structural floor and false ceiling horizontal sub-mains may also run around the perimeter of the building below window level. It must be noted here that floor ducts are difficult to water proof and maintain. They also cause a great deal of inconviniences when duct covers are to be removed. Floor ducts increase the floor to floor height. If horizontal sub-mains are unavoidable they should be carried above a false ceiling in the coriddor and distributed to the laboratires without further ducting.(18)

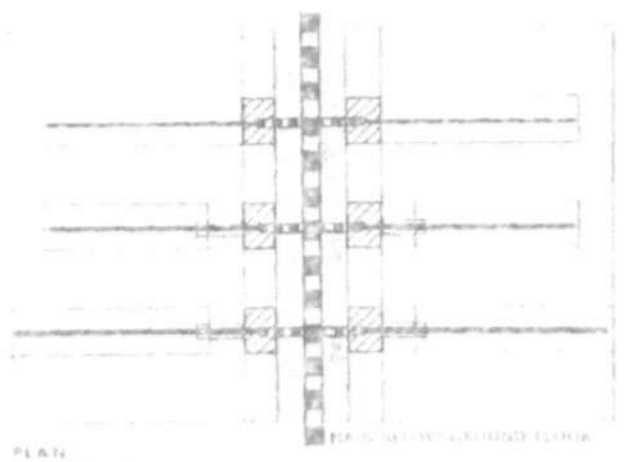
There are five main examples of systems making use of vertical, or horizontal or both sub-mains distribution.(19)

(i) Multiple interior shaft system:

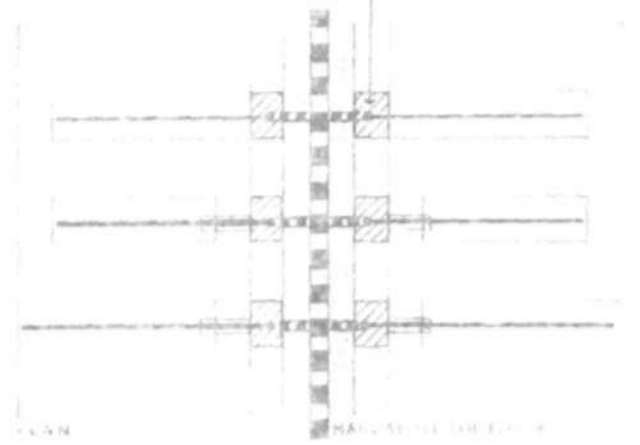
This system provides for concealed but accessible duct work and plumbing services in a series of regular shafts located on both sides or on one side of a circulation corridor. All services sub-mains are brought vertically to the various floor levels either upwards from the basement or downward from the mechanical room. (see figs 17 - 19)



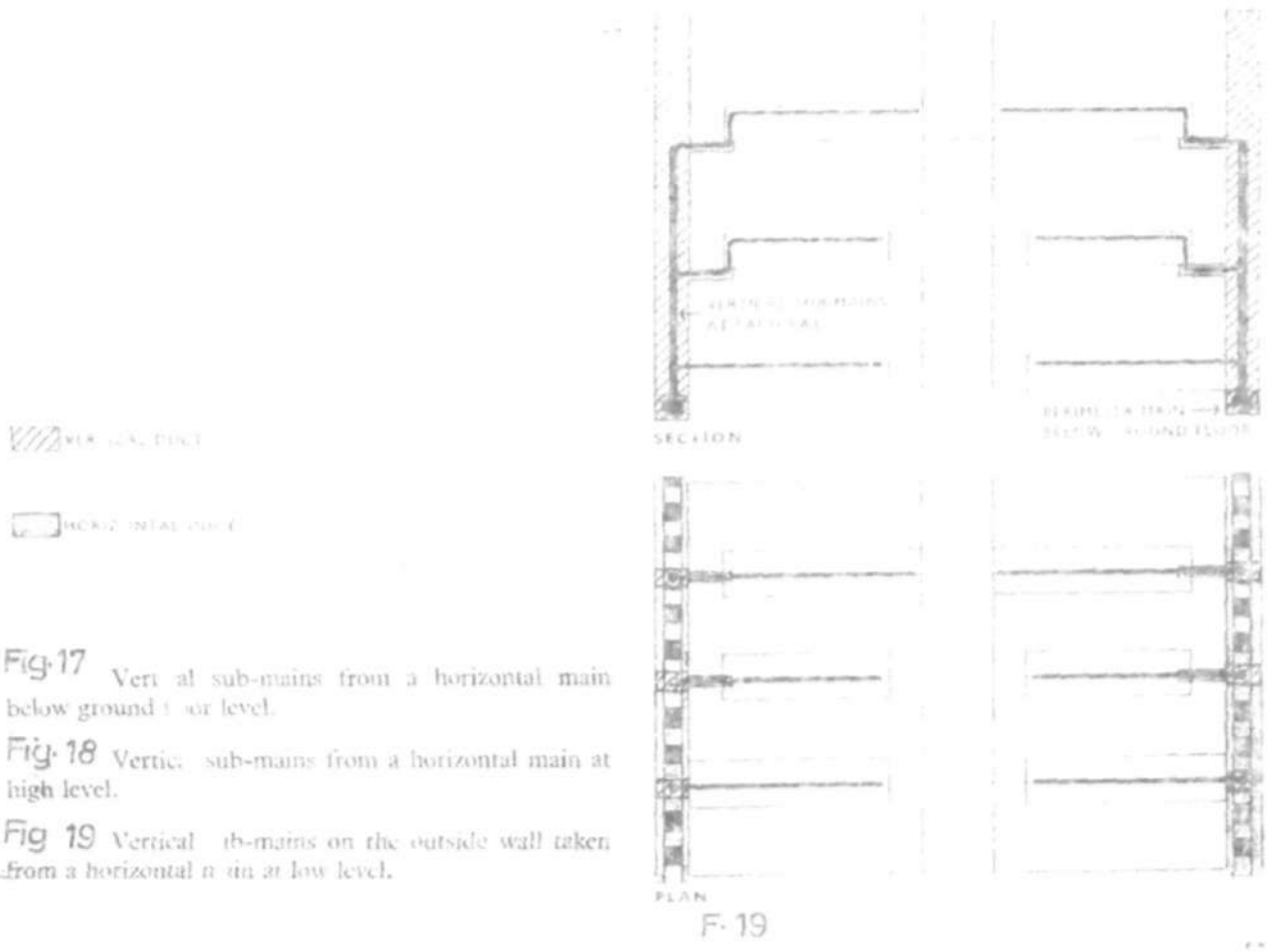




F. 17



F. 18



F. 19

Fig. 17 Vertical sub-mains from a horizontal main below ground floor level.

Fig. 18 Vertical sub-mains from a horizontal main at high level.

Fig. 19 Vertical sub-mains on the outside wall taken from a horizontal main at low level.

Distribution of services from the ducts in the shafts into the laboratory working areas is generally in the pipe space behind the laboratory bench. With the exception of the drainage lines, in some designs the services are extended from the services shaft below the ceiling in the laboratory and then brought downward to the benches. This system is most efficient for multi-storey buildings.

Advantages of this system include:

- Repairs and additions can be made to the services without interference to the laboratory worker.
- Enables services to be turned off from the corridor in the event of fire etc
- Depth of shafts is sufficient to contain outward opening laboratory doors (a safety feature) without interering with circulation in the corridor

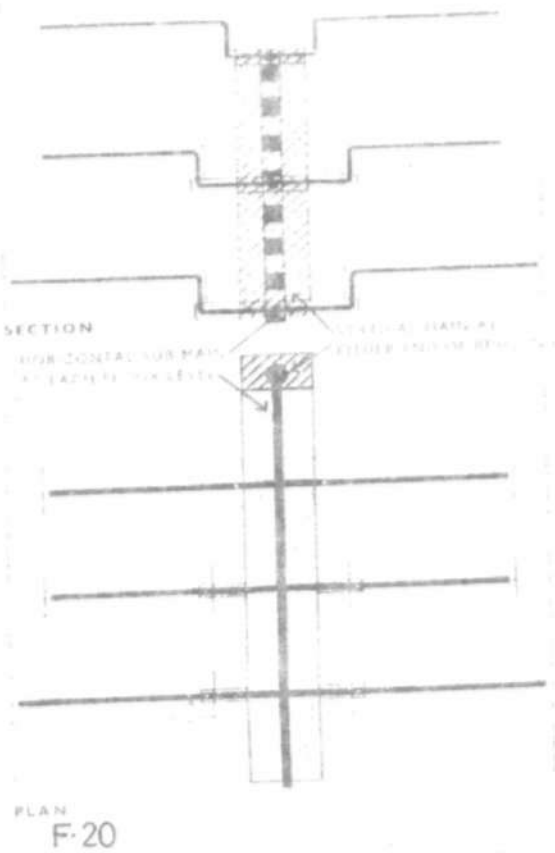
(ii) multiple exterior shaft system (see fig. 22)

This system is similar to the interior shaft system only that the vertical services shafts are located along the exterior wall at regular internals. Services are distributed from each of these exterior vertical sub-mains in the shafts into the laboratory rooms by means of the pipe space behind the bench or at the ceiling level. This system should only be considered for multi-storey buildings. The main disadvantage of such perimeter servicing is that alternations, or repairs to the services cannot be carried out without disturbing the activities in the laboratory.

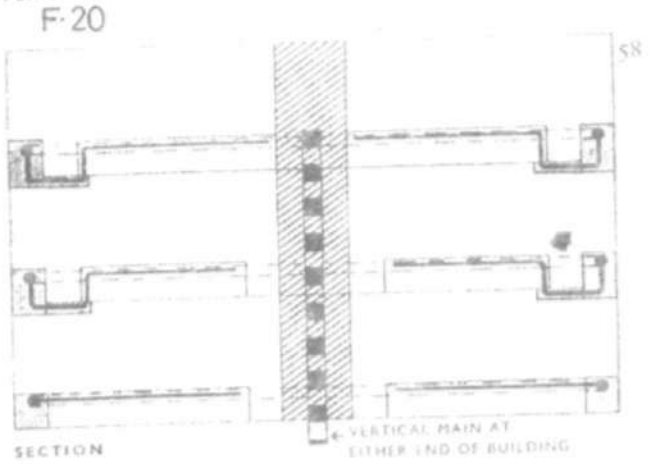
(iii) Corridor ceiling distribution:

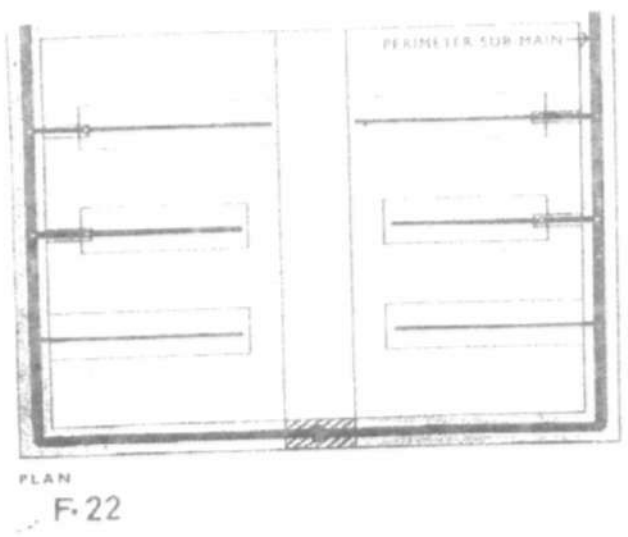
In this system services are located in the corridor ceiling and in some cases above the ceilings of the rooms on each side of the corridor and are supplied by one or two vertical pipe shafts. Distribution from the corridor such-mains to the laboratory areas may be downward to the floor or upward through the floor above in order to supply two floors from one ceiling arrangement. It is generally preferable to provide the distribution downward within each room to avoid perforation of the floor slab and consiquent leaks and flooding due to accidents.

This system is commonly used in research buildings with one or two floors.

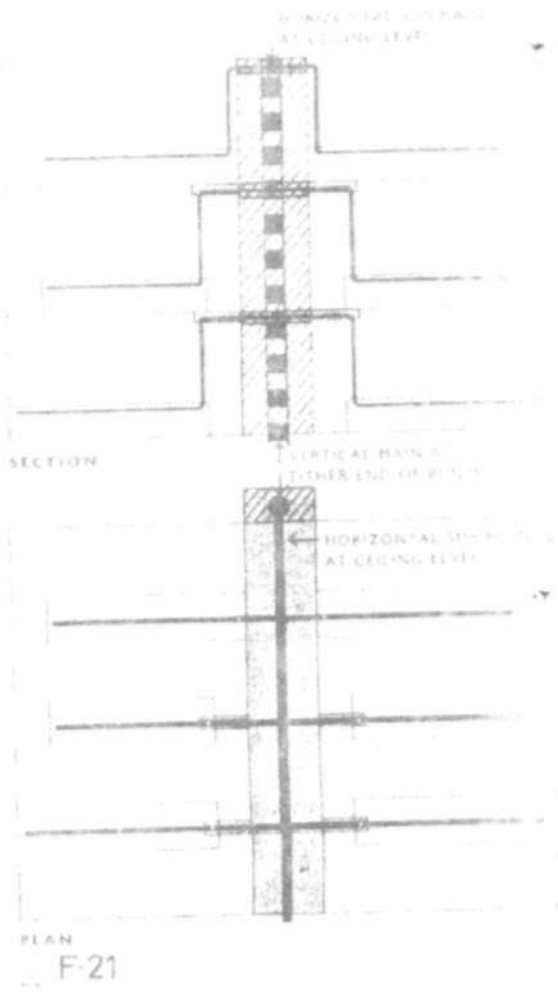


F·20





F·22



F·21

Fig·20 Horizontal sub-mains in floor ducts at floor level from a vertical main at one end of the building.

Fig·21 Horizontal sub-mains in the corridor between the structural floor and a false ceiling. Vertical main at one end of the building.

Fig. 22 Horizontal sub-mains around the perimeter below window level. Vertical main at one end of the building.

(iv) Service floor distribution: (see fig. 23)

In this system the services consisting of the ductwork and plumbing systems are in separate floors. The services mains are brought to each of the service floor by means of a centrally located vertical shaft or tower. Then sub-mains distribution is made laterally to each service floor with final distribution made by penetrating the floor above or below to service the laboratory areas. Though this system has unlimited flexibility, its cost is very high. The system can only be suitable for multi-storey buildings. A good existing example of this system can be found in the Salt Institute for Biological studies, California, USA.(20)

(v) Service corridor distribution:

In the service corridor design all services mains and ducts are brought to the various floor levels by means of a central core which distributes the services by vertical sub-mains from the basement or a roof mechanical room. The horizontal distribution to the laboratories may be at the ceiling and downward to the individual bench or it can be along the floor through the wall into the pipe space behind the benches.

This system provides access for maintenance and service personnel to the services throughout the life of the structure. It has a high degree of flexibility to meet the needs of changes in research programmes. The system is most applicable to multi-storey buildings - with a square rather than rectangular plan shape.

The main disadvantage is that all the laboratory rooms are likely to be "inside rooms" - if offices are located on the exterior walls.

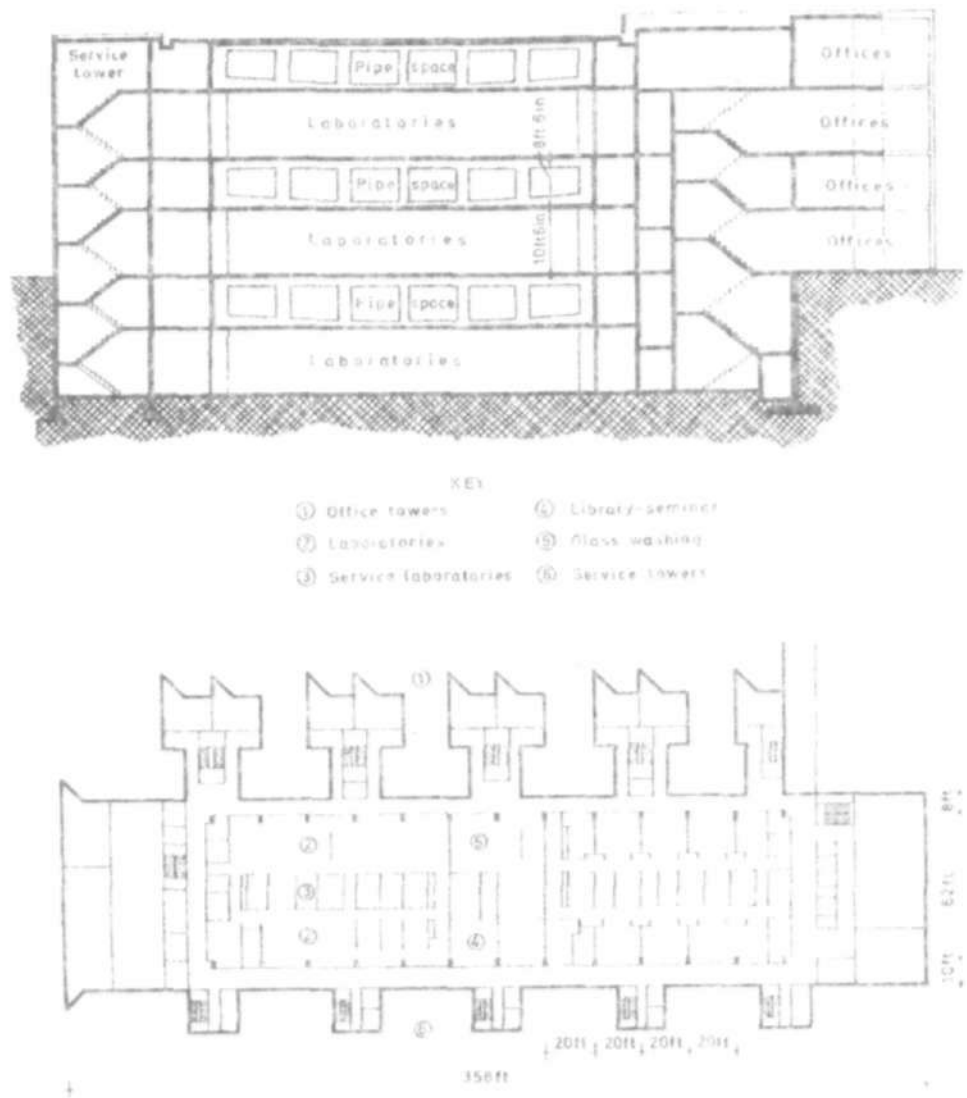
In general, complete and easy access to the services is very essential while provision must be made also for easy and rapid addition and adaptation to the services.

The factors which also affect design include:

- the number and types of services to be piped to outlets at the bench
- the routing of the services through the building from the point of entry of the mains to the bench outlets.
- the number of outlets required at bench position.

All those factors have a direct bearing on the degree of flexibility the ease and convinience of maintenance as well as the cost of installations.

Example: "service floor" system of services distribution
(see text)



Typical floor plan, and section showing service floors; Salk Institute for Biological Studies, California, U.S.A.

Fig. 23

It must be noted that services outlets and lines should be easily identified and distinguished. This is usually done by colour coding, shape of handwheel and labelling system.

3.2.08 SPECIAL LABORATORY PLANNING PROBLEMS:

SAFETY PRECAUTIONS (21)

In the design of laboratory buildings safety precautions are taken against hazards of two kinds: accidents and long term cumulative effects on health. Although the elimination of hazards is primarily a matter of internal organisation and discipline on the part of the people using the building, the designer can make safety precautions easier, and ensure that hazards are not built into the scientists' environment.

Design factors affecting safety:

(1) Overall planning.

- The local authority regulations governing overall planning requirements in relation to fire precautions will normally be adequate in allowing free movement of staff in cases of emergency.

(2) Layout of laboratory rooms.

(a) Escape routes - width of corriors, gangways and bench spacing should be such that will allow for free movement.

It is wise for all laboratories to have multiple exits - at least an alternative exit. For a laboratory allow an alternative means of escape at the end of the bench run remote from the corridor door - so that both doors cannot be simultaneously easily cut off by the same accident.

(b) Furniture-

Bench width is a critical factor in accident hazard. About 630mm width takes account of safety and efficiency. Benches, tables, chairs, cupboards etc. should be stable so that they cannot be overturned by pushing or leaning.

3. Storage:

(a) In the laboratory -

Inflamable liquids, reagents etc should not be stored at back of bench because of the danger or spilling when reaching forward. An adequate and easily accessible store is essential to safety in laboratory rooms. For cupboards or drawers below bench a maximum depth of about 540mm (1' - 9") is safe for handling.

(b) Bulk storage -

(i) Poisons should be kept in a separate room or cabinet

(ii) Inflamable and explosive materials may have to be stored depending on local building regulationsin detached fire proof buildings or at least in a fire proof room with access to the open air only. Good natural and artificial ventilation is essential.

(iii) General storage should be located near the laboratory with adequate trolley access, to reduce distance of carriage. Good lighting and ventilation are essential.

4. Service outlets and controls:

Service outlets and control should be placed so that the user does not have to run the risk of accidentally coming in contact with apparatus on the bench.

5. Drainage and waste disposal:

It is of great advantage to keep waste lines above floor level so that faults are easily evident. Such waste lines can then simply be run directly to a vertical stack - this is straightforward with vertical sub-mains systen of services distribution as the structural services shafts would already be existing.

Waste bins should be provided for each class of solid waste e.g. glass paper, chemicals etc.

6. Electrical Installations:

All electrical istallations should be earthed. To reduce accidents due to improvised wiring, genourous electrical outlets should be provided. Insulated floor finish and bench tops may help to prevent injury.

7. Fume disposal:

Carbon dioxide extinguishing systems are advisable to be handy by fumecupboards. For practical purposes fume cupboards should be located near the vertical ductwork because direct vertical extract ducts are more efficient than those which have considerable horizontal runs. Vertical sub-mains services dustribution system is an advantage.

Protective and first-aid equipment:

Provision of protective and first aid equipment must be made and placed in conspicuous places in the laboratory to encourage their use.

1. Protective clothing:

- Provision should be made for the storage and easy access to gloves, eyeshields, overalls, gas and dust masks. Others are asbestos clothing for protection against heat and flame; rubber clothing and shields for electrical and mechnical protection.

2. Protective Equipment: incude fume cupboards, plastic shields, remote handling equipment and glove boxes (for radioactive substances,

3. Emergency showers and wide spray fittings are usually placed close to a door and should be easily identified and operated. In the absence of showers and sprays, there should be at least a large sink that is capable of taking head and hands at the same time.

4. First aid boxes should be provided along corridors or in special but easily reached and located rooms.

5. For fire fighting apparatus see "Fire Precautions"

FIRE PRECAUTIONS:(22)

The design of the laboratory building should aim at providing amply for passive and active defence of the building in the event of fire. The design can only take care of in built precautionary measures, the prevention of fire or any accident is largely a matter of staff discipline and training.

Causes of Fire: Causes of fires in the laboratory are in descending order of frequency:

- naked flame
- electrical defects
- electric heat source
- chemical reaction
- unknown.

Fire hazard: Fire hazard could be divided into three categories:

(i) Damage hazard to the structure and its contents. The effect on the structure is in relation to building size and combustible content.

(ii) Personal hazard to the occupants. This effects the planning of the building (travel distance; corridor and staircase arrangement, the prevention of flame spread; the restriction of smoke spread etc)

(iii) Exposure hazard to fire spread from sorrounding buildings. This problem is same for all buildings.

Planning against personal hazard:

There are four main ways of planning for the safety of laboratory workers:

(i) The provision of suitably located exits

(ii) Limiting travel distance to exits or to some point protected by compartmenting to allow occupants of the building to escape before there is an appreciable accumulation of smoke and hot gases in corridors and circulation areas generally.

(iii) The provision of corridors and staircases of adequate width

(iv) The provision of adequate escape routes from working positions even if such an alternative exit opens to another room.

Spread of smoke and flame can be prevented by providing fire resistant and smoke stop doors and partition walls - abutting corridors and stairs.

Services distribution and fire hazard:

Some fires start from the services duct and spread to other parts of the building. The continuous ducts would then act like chimneys and the spread of flame will be rapid if the cross-section of duct is small. Ducts should therefore be made of inconbustible materials and as large a cross-sectional area as possible. Fire stops or breaks should be placed at intervals in the ducts. The ventilation systems can be arranged so that they can easily be turned off. Equipment such as fume-cupboards should be made with floor of inconbustible materials; and the glazing should be of heat resisting glass if high temperature work is involved.

Fire detection and alarm systems

All laboratories should have both manual and automatic fire detection and warning devices which simultaneously sound an alarm in the building and at the fire station.

The manual systems which are mainly for warning purposes consist of press buttons.

Automatic systems available so far include:

- thermal alarm
- sprinkler
- smoke detector
- carbon dioxide and
- halogenated hydrocarbon.

In built-up areas where the services of a fire brigade exists, it is usual to install thermal alarms in buildings of medium risk, and sprinklers in buildings of high risk; the other systems are designed for special conditions.(23)

Fire proof rooms:

At least one fire proof room should be provided in every laboratory building in order to give maximum protection to valuable items of equipment and irreplaceable records.(24)

Fire fighting equipment:

It is important for all categories of laboratory workers to be trained and have the knowledge of at least elementary precautions to be taken to prevent the out break of fire.

The following equipment may be provided in each laboratory:

-buckets filled with sand or earth

-carbon dioxide extinguishers

-blankets; various types of asbestos blankets are available for smothering small bench fir

-showers at the entrance or exit door; this being a worthwhile precaution against personal fire hazard as ones' clothing catching fire could easily be extinguished by means of a shower without alarming other workers.

Hoses should be installed especially if buildings are not easily accessible to the fire brigade.

All equipment must be conspicuously located and as much as possible located at similar places e.g. particular recesses on each floor.

THE REDUCTION OF VIBRATIONS(25)

Research work usually involves a wide range of apparatus and equipment, many of which are likely to be affected by vibration. Such apparatus or equipment include sensitive balances, galvanometers, mirror extensometers, optical and photographic equipment and electronic equipment.

Sources of Vibrations:

Sources of vibrations invcude road and rail traffic, nearby electrical and mechanical machinery, door slamming, heavy foot traffic within the building.

Measures to prevent transmission:

(i) Planning against vibration by giving due consideration to sources of vibration while choosing the site. Buildings should be kept as far away as possible from sources of vibrations; and within the buildings h eavy plants should be located with their potential nuisance value in mind.

(ii) Isolation of machinery as a measure aimed at reducing vibration at source by providing anti-vibration mountings for the machinery.

(iii) A whole floor can be isolated by spring mountings, especially for small rooms.

(iv) Apparatus may be supported on isolated piers as a measure against vibration produced in the same room as the apparatus. This usually applies to ground floor and basements only.

Calculations are necessary to determine correct form of mounting, though commercial mountings have been developed.

(v) Use of load bearing or reinforced concrete frame construction.

(26)

THE PROBLEM OF NOISE:

Much of the work carried out in research laboratories require a high degree of concentration and needless to say that the nuisance of noise will seriously impair efficiency. With such desierable quiet

environment necessary for the conventional research laboratory, heavy engineering and testing laboratories need special consideration.

It must be noted that noise reduction and the prevention of structural vibrations are related subjects, many of the measures taken for one being effective for the other .

There are three stages in the prevention of noise: reduction by planning; reduction at source; and structural measures.

(i) Planning against noise:

The reduction of noise through planning begins with the choice of site in relation to sorrounding noise sources. However, the disposition of site with a view to noise reduction must be weighed against other vital aspects of planning such as the availability of mains services and the access.

The most important aspect of planning against noise is in the disposition of the parts of the building in relation to each other and the internal arrangement of rooms. Some zoning into quiet and noisy parts is desirable while rooms that are used for only short periods and are themselves quiet (e.g. stores, dark rooms etc) can be placed in between as buffers. Ideally, very noisy rooms (eg loading bays boiler rooms, motor and compressor rooms) should be in separate buildings.

In multi-storey laboratories, sources of structure borne noise should if possible be placed at ground floor or basement levels.

It must be noted that planning against noise both on site and in the building itself costs nothing !

(ii) Noise reduction at source:

This is also an inexpensive method of noise control - being enshrined in good design and choice of materials;

e.g.- floor finishes (against footsteps)

- silent door closers (against door bangs)
- resilient tyres to trolleys and moveable cupboards.
- rubber shod chairs and tables
- choice of quiet equipment for buildings (electric fans, electric motors, compressors, water systems, ventilation and air - conditioning systems)

(iii) Structural measures against noise

Structural measures against noise are achieved mainly through sound insulation, absorption and the reduction of vibrations. The use of partitions, floating floors and absorbent treatment to hard surfaces also helps to reduce noise transmission.

3.2.09 LAYOUT OF LABORATORY BUILDING:

Whilst the planning of each laboratory building has its individual problems, the range of layouts developed and used satisfactorily over the years can be narrowed to about four main types: Off-centre corridor type; central corridor types; Double corridor type; and the service corridor type.(27) Each type has variations depending on the locations of offices, laboratories and service laboratories.

OFF-CENTRE CORRDOR TYPE:

In this type of layout, as the name suggests, the circulation corridor is not centrally located with respect to the width of the building i.e. rooms on either side of corriddr are of different depths. It has the advantage that all the laboratories can have a south facing or north facing aspect as desired, and the two room depths provide flexibility in planning.

CENTRAL CORRIDOR TYPE:

This layout is suitable for very large schemes and has the advantage that the grouping of laboratories is more compact because they are on both sides of the corridor.

DOUBLE CORRIDOR TYPE

This layout has laboratories on both sides of a centrally located service laboratories and provides a good interrelationship between labortory, laboratory offices and service laboratory. It has the advantage that as the service laboratories are windowless, it is easier to obtain accurate temperature control while in some cases, the absence of natural light is an asset.

SERVICE CORRIDOR TYPE:

This layout has a special service corridor located centrally and flanked on both sides by laboratories with very complex services, and where temperature control is very critical.

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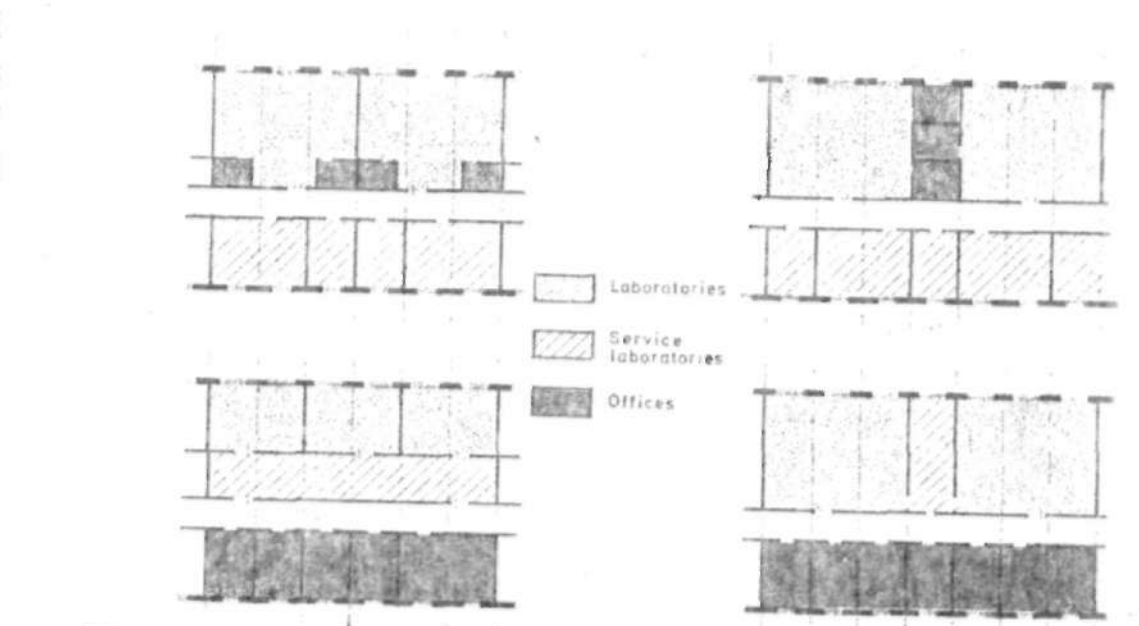
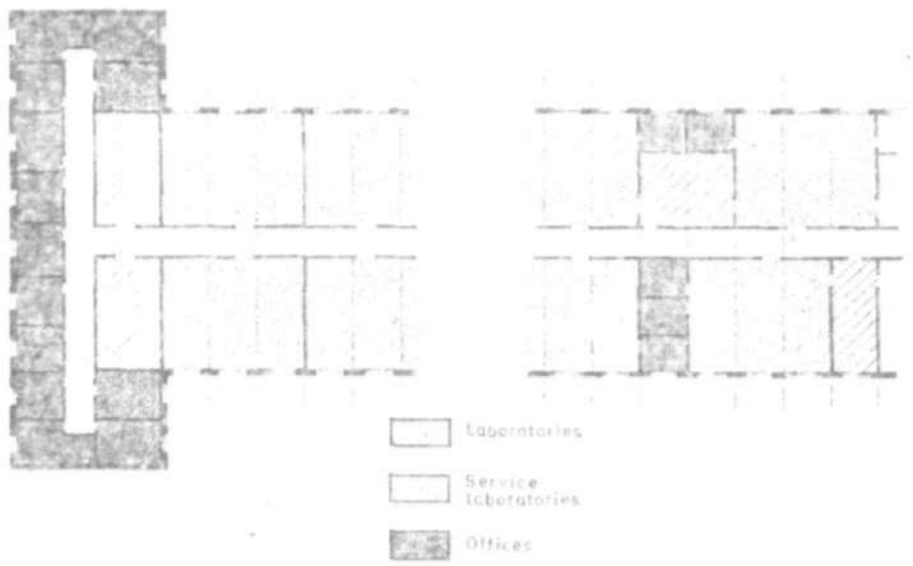


FIG. 24 *Off-centre corridor layouts, showing the relative positions of laboratories, service laboratories and offices.*

CENTRAL CORRIDOR TYPE:

This layout is suitable for very large schemes and has the advantage that the grouping of laboratories is more compact because they are on both sides of the corridor.

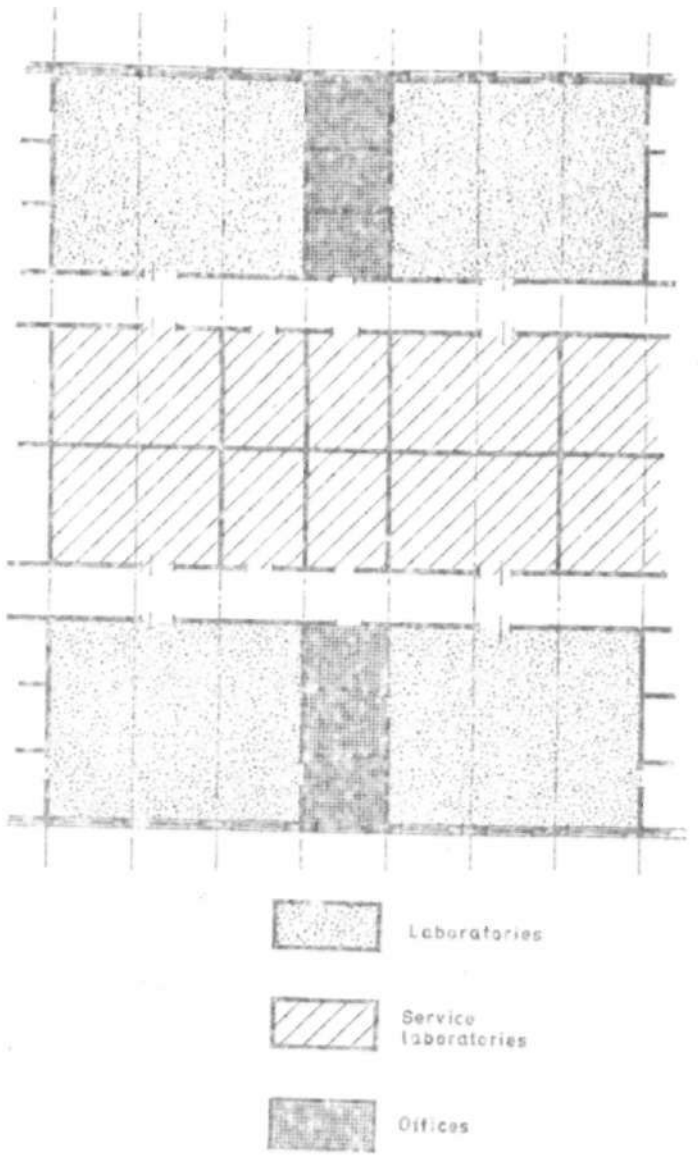
shown below are two variations
of central corridor type of laboratory building layout



FIG·25 *Central corridor layouts, showing the relative positions of laboratories, service laboratories and offices.*

DOUBLE CORRIDOR TYPE:

This layout has laboratories on both sides of a centrally located service laboratories and provides a good interrelationships between laboratory, laboratory office and service laboratory. It has the advantage that as the service laboratories are windowless, it is easier to obtain accurate temperature control while in some case, the absence of natural light is an cost.



PG-28 *Double corridor layout, showing relative positions of laboratories, service laboratories and offices.*

SERVICE CORRIDOR TYPE:

This layout has a special service corridor located centrally and flanked on both sides by laboratories. This scheme is usually for laboratories with very complex services, and where temperature control is very critical.

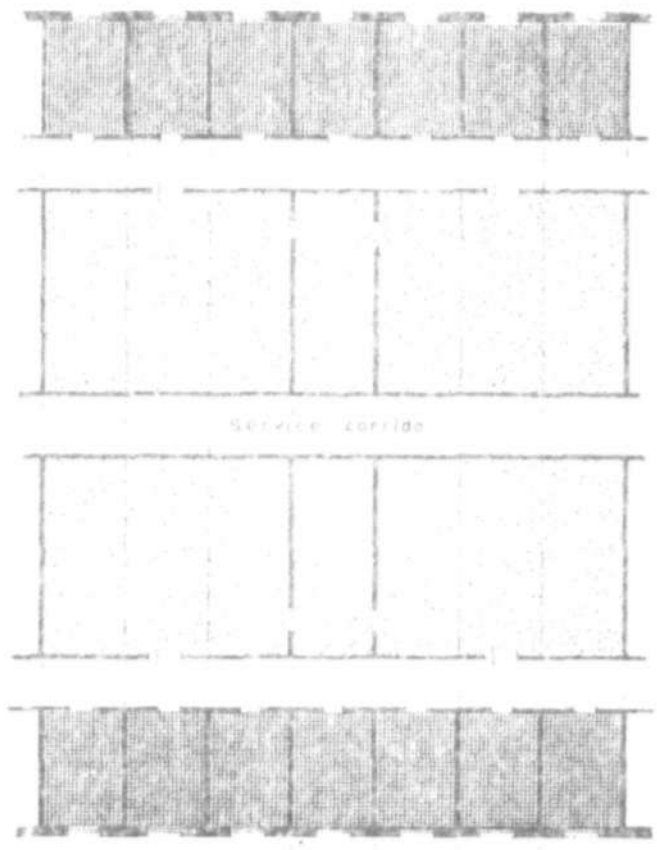


FIG-27 *Double width layout with service corridor showing relative positions of laboratories, service laboratories and offices*

3.2.10 DESIGN OF LABORATORY BUILDINGS:

The rectilinear shapes of most laboratory fittings, equipment and the office furniture and the need for continual interplay between rooms call for utilitarian solutions.

Buildings with simple rectangular configurations, commensurate with standard laboratory equipment and office furniture, as mentioned above, and with unrestricted accessibility to mechanical and services systems are the easiest to adapt to the changing needs of research.

FLEXIBILITY AND CAPABILITY

Research needs change with time and for this reason, the term FLEXIBILITY is frequently used in discussing the design characteristics of research laboratory buildings. However, flexibility should be interpreted with caution because most research laboratory structures should be designed with the concept of CAPABILITY in mind.(28)

- The structure is capability to meet ventilation needs for different research functions
- Its ability for temperature control of varying heat loads
- Its capability to meet the needs for fume hoods, air supply, and exhaust in different concentrations with time in various areas of the building are critical.
- The ability to supply electric power in high concentrations to any localized area without the need to reposition electric distribution lines within the building is a measure of the structu capability to meet the needs of the research programme that will eventually occupy the building.

It can be said then that in the design of research laboratory buildings, FLEXIBILITY can be provided in the laboratory areas by the wise positioning of the service sub-mains. Demountable partioning is essential but not always essential. Provision for its erection is normally made along the grid.

Planning for Eloxibility and Growth

Efforts are being made by architects to develope comprehensive systems which will relate the needs of the various disciplines and departments in research institutions or any higher institution of learning and provide ways of sharing some facilities while recognizing the increasingly interdisciplinary nature of much scientific research and the need for planned expansion and growth.

The system developed by sir Leslie Martin[29] consisted of a regular grid derived from considerations of space, lighting and intergrated systems of structures and services. The grid formed 35- ft squares separated by 5-ft strips. Ducts can be introduced at any point within t ese strips. The system was also divided vertically with large areas like lecture halls, workshops and special laboratories for heavy equipment at lowest level and other research laboratories, etc above.
The grid could be applied to site giving a rough indication of present areas and future expansion so that the architectural development can go on in stages in relation to the grid, forming segments of a larger system rather than single buildings.

In the planning and the design of the University of Loughborough in England, the Arup patners developed a system similar to that men ioned above. Their system consisted of grids/ --- of 50 feet squares separated by 15 feet "separation" grids.
This double grid system was used for the planning of the whole campus with present and future expansions considered.

Number of storeys:

For a compact layout of laboratories and services single storey buildings are not advisable, for one thing they lend themselves to extravagant use of land though single storey buildings have the merit of being easily altered and extended. Three storey and occasionally four-storyy schemes provide satisfactory and economic solutions.

It is interesting to note that some laboratories are organized as towers rather than horizontally: A good example being Ulrich Franzen's laboratory tower at Cornell[30]

Future Expansion:

The need for making provisions for the future expansion of the laboratory building hardly need elaboration because of the anticipated expansion in research work with time.

One way to take care of future expansion is to design for "under use" so that unallocated spaces could be absorbed. Such a measure is a short-term provision.

As a long-term planning measure, provision should be made for the expansion of the building by simple additon or extension at the ends of another building in close integration with the earlier ones.

Structures:

In laboratory buildings, the structures should be such that will keep vibration to a minimum, in addition to satisfying all other building regulations. The simplest way to minimize the transmission of vibration is to use heavy contruction. Load bearing walls with reinforced concrete floors are most effective and reinforced concrete frame is preferered to steel.

The provision of a roof-space is desirable and should have access stairs and enough head room. The main items that could be installed in the roof space include fume.- cupboard exhaust fans, air conditioning equipment and ducts, distilled water units, cold water supply tanks and water treatment plant.

Elevators:

Provision must be made for bringing large equipment into the laboratories. The use of a cathead and hoist in the past proved unsatisfactory. "The cost of a goods/Passensger elevator is justified - certainly for three storey, and if possible two storey buildings."(31)

The oil-electric hydraulic type combines the advantages of low initial cost, less maintenance, smaller plant room (on the ground floor instead of the roof) and less vibration. The interior dimensions of the car should not be less than 1.5m x 1.9m.

Orientation of building:

In order to obtain the best working conditions and to avoid sun shining on scientific equipment, it is essential that laboratories be correctly orientated with regards to the exposure of the windows to to the sun. In laboratory planning this is one of the most important decisions, and simply means that a building should have north or south facing windows.

Care must be taken also in the choice of type, size and location of the windows to avoid discomfort glare and to effect a good distribution of natural light.

In non-air conditioned rooms the windows must be openable. In air conditioned rooms most of the windows should be fixed to avoid dust infiltration etc but at least one should be openable in case of air conditioning failure

Partitions:

In load-bearing construction, one of the corridor walls and some of the cross walls are structural, but in framed construction, all internal walls are non-load-bearing. In order of importance the main requirements of partitions are that they be fire-resistant, sound-proof and demountable. Brick and concrete block and timber frame sheeted both sides with flush jointed 13 mm thick fibrous plaster or 16 mm plaster board all have 1-hr fire rating and are commonly used.

It must be stated, however, that for demountable partitions generally, the fire - resisting and sound-proofing qualities are poorer than with conventional construction and the initial cost is higher, and there may be no real benefit in using them for laboratories as the altering of laboratory sizes do not take place as often as might be supposed.(32)

Other Factors:

Economy of construction may sometimes conflict with efficient operation: For example, bench areas and special installations of the laboratory building require elaborate piping services and air conditioning, whereas the offices, conference rooms and storage areas do not.

In terms of economy it makes sense to group like functions and like areas, i.e. to separate office space etc from the research area; but most scientists prefer their offices to be near to their research while special installations also need to be closely associated with research.

Resolving these contradictory requirements while still providing for flexibility and growth is one of the most difficult problems in designing a laboratory building. (see "Layout of Laboratory buildings " above)

LABORATORY FITTINGS:

.11 A catalogue of laboratory fittings include benches, fume-cupboards, reagent shelves, balance and instru ment benches etc.

It is advisable to have laboratory fittings that are of standard design. The advantages of standard design include use of fewer-drawings for the architect to prepare, the savings in cost of manufacture and installation and the re-use of units even if laboratory layout is altered. There are some standard fittings being manufactured and choice could be made to suit requirements. Fittings for specific and special purposes have to be designed and purpose - made.

In research laboratories, as a result of unforseen needs, some fittings are self- constructed and necessitated by a particular experiment.

A TYPICAL RESEARCH LAB·
SERVICES INSTALLATIONS
(notice vertical sub-mains distribution to the floors, the horizontal distribution to the laboratories and the safety shower above the "outwards" opening lab door

compare figs 13-23)



FIG 32 *Plan and section showing corridor service shafts; Homer Research Laboratories, Bethlehem Steel Corp., Pennsylvania, USA.*

LABORATORY FITTINGS

Example of horizontal distribution of services
(see fig. 30)

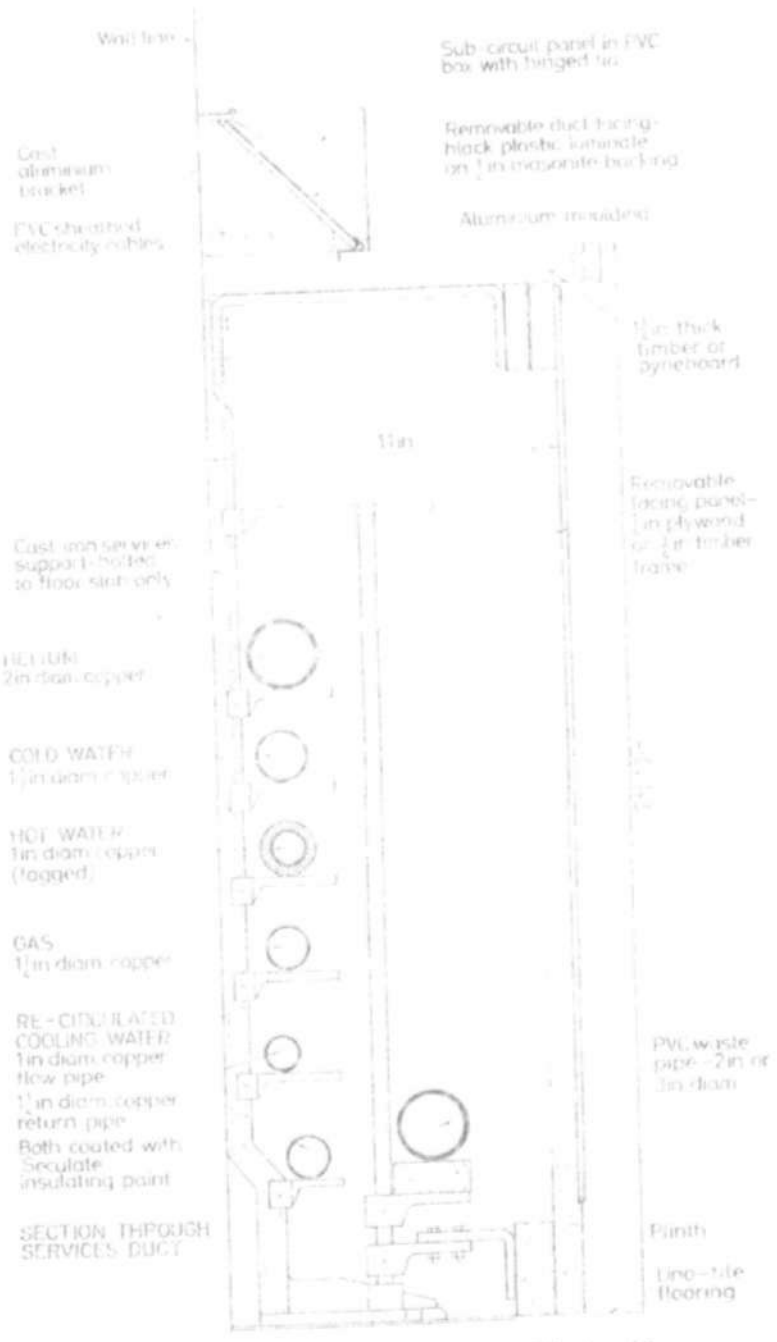


FIG-31 *David Rivett Laboratory, Clayton, Vic.*

A TYPICAL RESEARCH LAB·

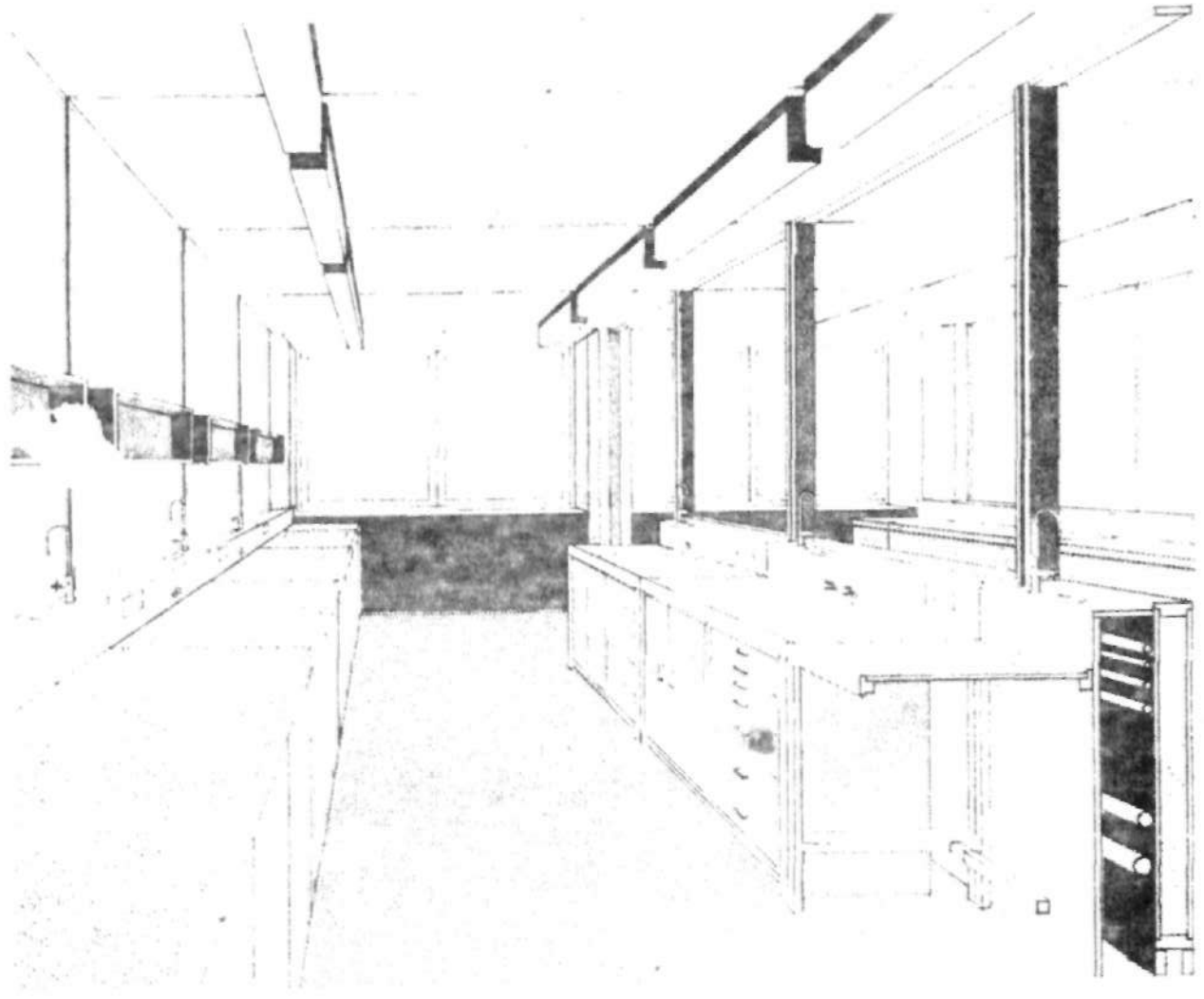


FIG. 30 Servicing layout, unit partitioning, and furniture designed for the new Laboratories of the Imperial Cancer Research Fund, London.

LABORATORY FITTINGS :

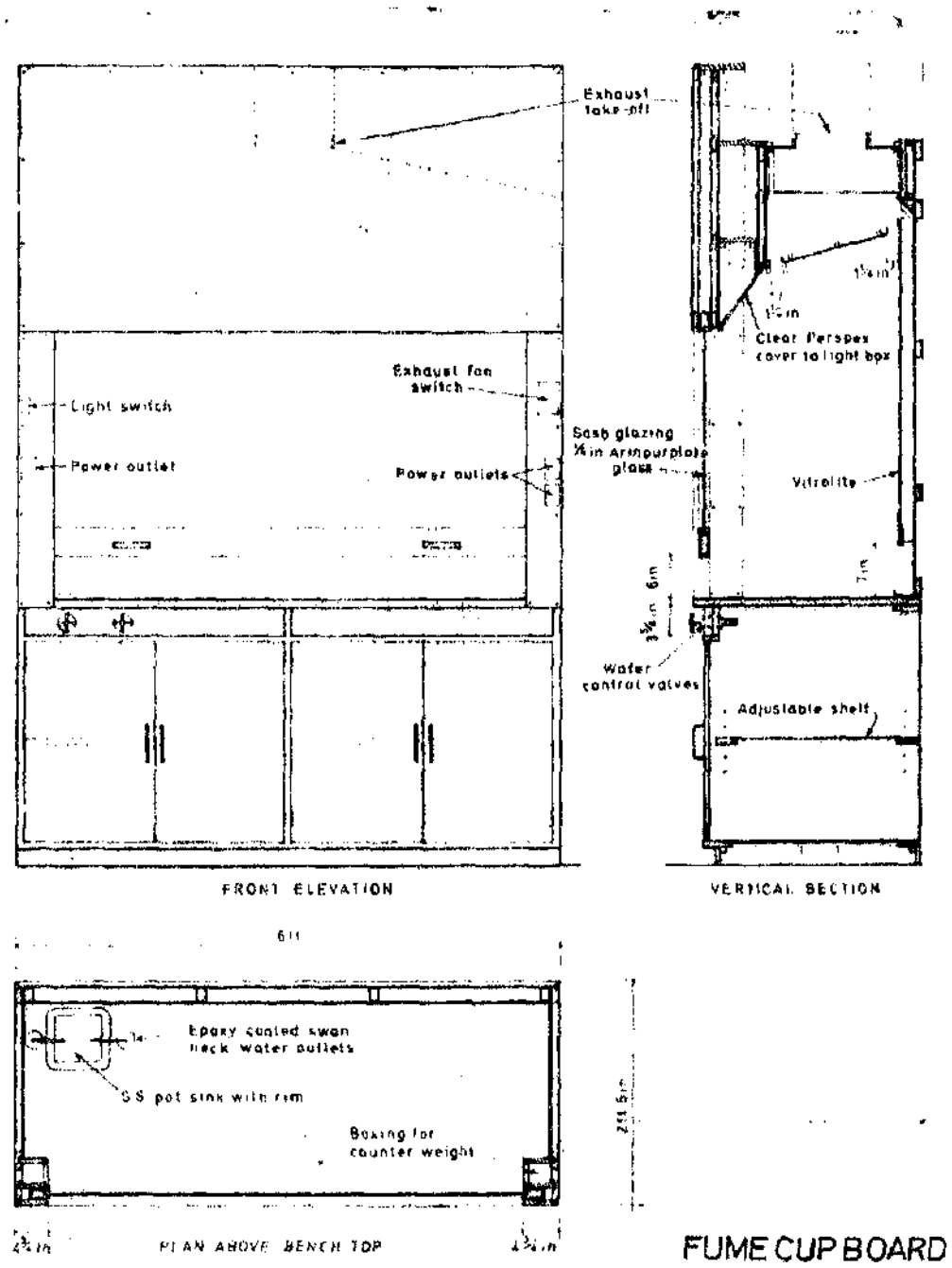
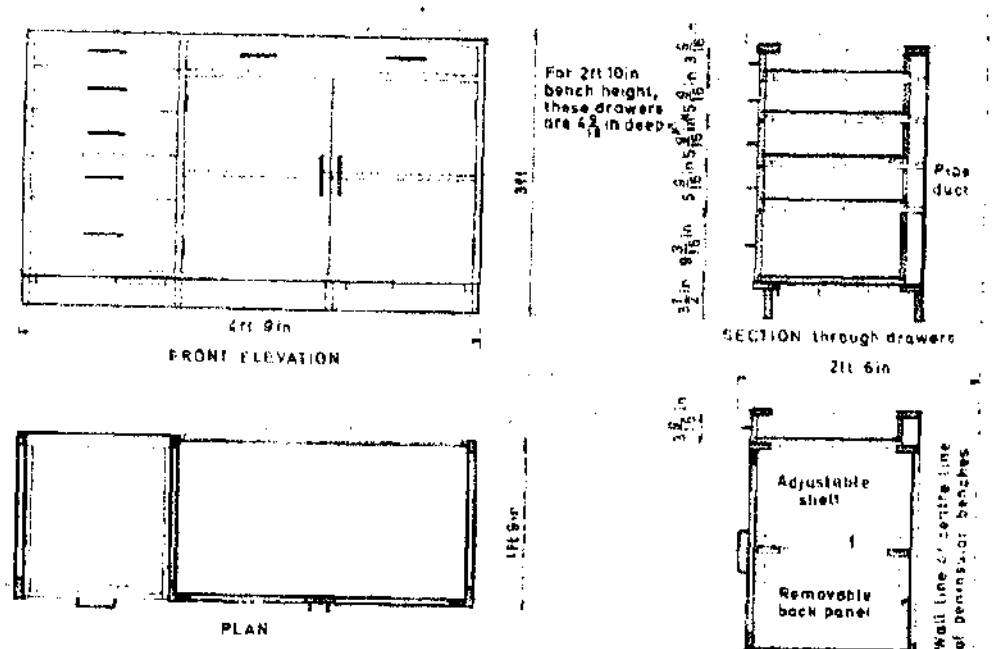


FIG. 28 *CSIRO standard fume cupboard with sash.*



LAB. BENCH UNIT

FIG. 29 *Typical construction details for CSIRO standard bench units : the unit shown is Type A2*

SITE PLANNING STUDIES

3.3.00 The main problem when considering and planning a " master-plan" for a Research centre is to provide effectively for growth. The growth may not be easily predictable, therefore the principal objective in the planning is to provide for expansion to take place without disruption to what has already been built.

In drawing up the development plan the method of "town planning" and more specifically, "campus planning" principles must be used: This means that traffic routes must be established and the site zoned for development. The zoning should be such that expansion could take place in each zone with minimal disruption of circulation routes on the site. (35)

3.3.01 Approaches to the planning of research institues based on the above guidelines are described below:

CENTRAL FOCUS: -
The planning is composed of buildings of common use located in a central focal area with regards to other buildings. Such buildings include the library and canteen. This arrangement is convinient for departments close to the central area, whereas, it is less convinient for those progressively farther away.

MULTI-FOCI - Another approach is to provide for multiple foci from the start of the institution. This type of planning is suitable for an institution that is likely to grow to a known or pre-determined extent. It must be noted also that the distribution of services may be expensive.

COMPACT - The compact design approach in an extreme situation has all the laboratories, offices and central amenities in one building. This type of planning is suitable for small establishments. It must be noted that an attempt to have a compact but expandable complex is desirable as this will cut down on costs of services distribution and effect a close link between the component departments of the institution.

LINEAR CENTRAL

The linear central planning provides for central facilities in a linear form, placing libraries, workshops, stores etc along a street running down the centre of the site. Such a plan has the advantage of being open ended and can be extended as the need arises.

In general thorough consideration must be given to vehicular access and the car- parking space.

The eventual system of planning to be adopted should be functionally related to the type of research institution being planned for.

Footnotes

(1) Munce J.F. Laboratory Planning, London Butterworths, 1962, P. 92
(2) Op. cit P. 110
(3) Chiara J., Time Saver Standards Building Types P. 860.
(4) Supra
(5) Nuffield Foundation, The Design of Research Laboratories, London, Oxford University Press 1961, P. 38
(6) Op. cit PP. 41 - 42
(7) op. cit PP. 45 - 46
(8) Op. cit P. 46
(9) Op. cit P. 42
(10) Op. cit. P. 47
(11) Op. cit. PP. 48 - 50
(12) Op. cit. PP. 155 - 159
(13) Op. cit. P. 57
(14) Op. cit. P. 157
(15) Op. cit. PP. 48 - 50
(16) Op. cit. P. 75
(17) Chiara J. & Co. Time Saver Standards Building Types P. 866
(18) Nuffield Foundation, The Design of Research Laboratories PP. 76 - 84
(19) Chiara J. & Co. Time Saver Standards PP. 867 - 872
(20) Ferguson, W.R., Practical Laboratory Planning, Lond, Applied Science Publishers Ltd, 1973, P. 20
(21) Nuffield Foundation The Design of Research Labs. PP. 143 - 153
(22) Op. cit PP. 130 - 142
(23) Ferguson, W.R., Practical Laboratory Planning P. 92
(24) Op. cit. P. 90
(25) Nuffield Foundation, The Design of Research Labs. PP. 125 - 130
(26) Op. cit. PP.119 - 125
(27) Ferguson, Practical Lab. Planning PP. 18 - 20
(28) Chiara, J. & Co., Time Saver Standards, Building Types, P. 885
(29) Op. cit P. 866
(30) ibid
(31) Ferguson, Practical Lab. Planning P. 26.
(32) Op. cit. P. 34
(33) Nuffield Foundation, The Design of Research Labs. PP.154-1[illegible]

PART IV

THE SCHEME OF DESIGN PROPOSALS

Chapter 1. The Brief and Accommodation Schedules

Chapter 2. General Planning Considerations

Chapter 3. Establishing the Design Modules
- The laboratory Unit
- The Laboratory layout
- Services Distribution

Chapter 4. The site in Kaduna
- Land-Use map of Kaduna
- Environmental Determinants

Chapter 5. Architectural character of Design
- aim
- Land-mark
- structures

THE BRIEF AND ACCOMODATION SCHEDULES

4.1.00 Outline of Brief

The provisions being proposed for the efficient functioning of the "National Centre for Scientific Research and Development" comprise facilities for Administration, Research, Services and maintenance and Housing .

(a) Administration

- Main Entrance with covered "drive-in"
- Entrance Hall with large exhibition area, reception, waiting and toilet facilities.
- Offices for internal administration and external co-ordination
- Provisions for "Local" or internal conferences and larger conferences involving national and international delegations.
- Provisions for general public information of research results. etc
- Provision for mail services
- Unallocated spaces on the ground floor for unforseen uses.

(b) Ancillary Facilities

- central Research Library of 100,000 collections
- sectional libraries
- Publication unit
- closed circuit Television unit
- computer unit
- Staff canteen
- Health clinic
- Recreation facilities

(c) Services, Operations and maintenance

- offices
- central storage
- maintenance yard, workshops and garages
- standby power plants
- Boiler house
- water, electricity, gas control
- sewage disposal plants
- Fire station
- Refuse diposal (incinerators)

(d) Research Facilities

- General Laboratories
- light technical laboratories
- heavy technical laboratories
- offices for scientific staff
- seminar rooms
- sectional library
- services control rooms
- Instrument workshops.

(e) - Housing

- For permanent staff
- Guests

(f) Security

- Gatehouse with guards at access points.
- Fencing all round the centre

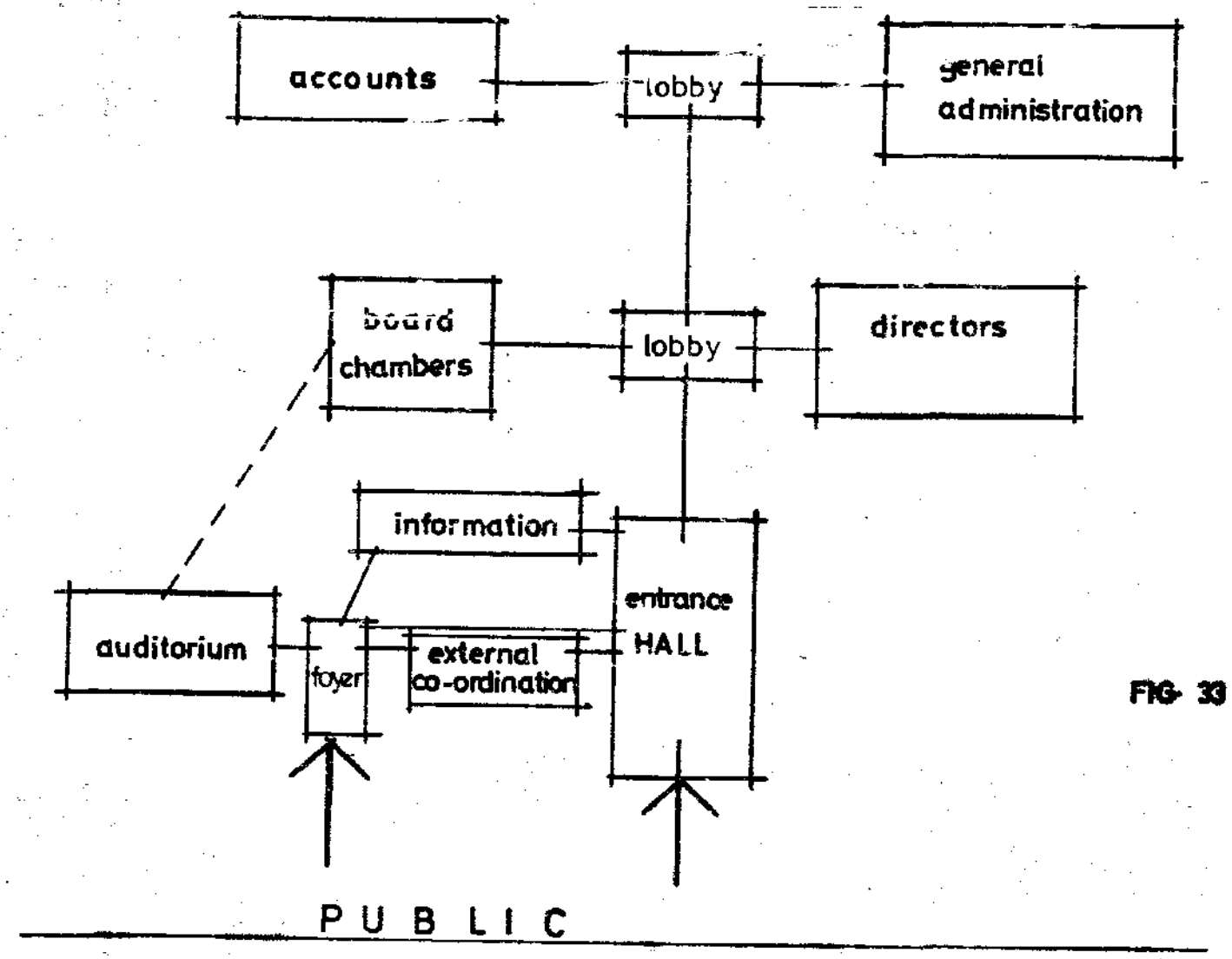


FIG 33 ADMINISTRATION flow diagram

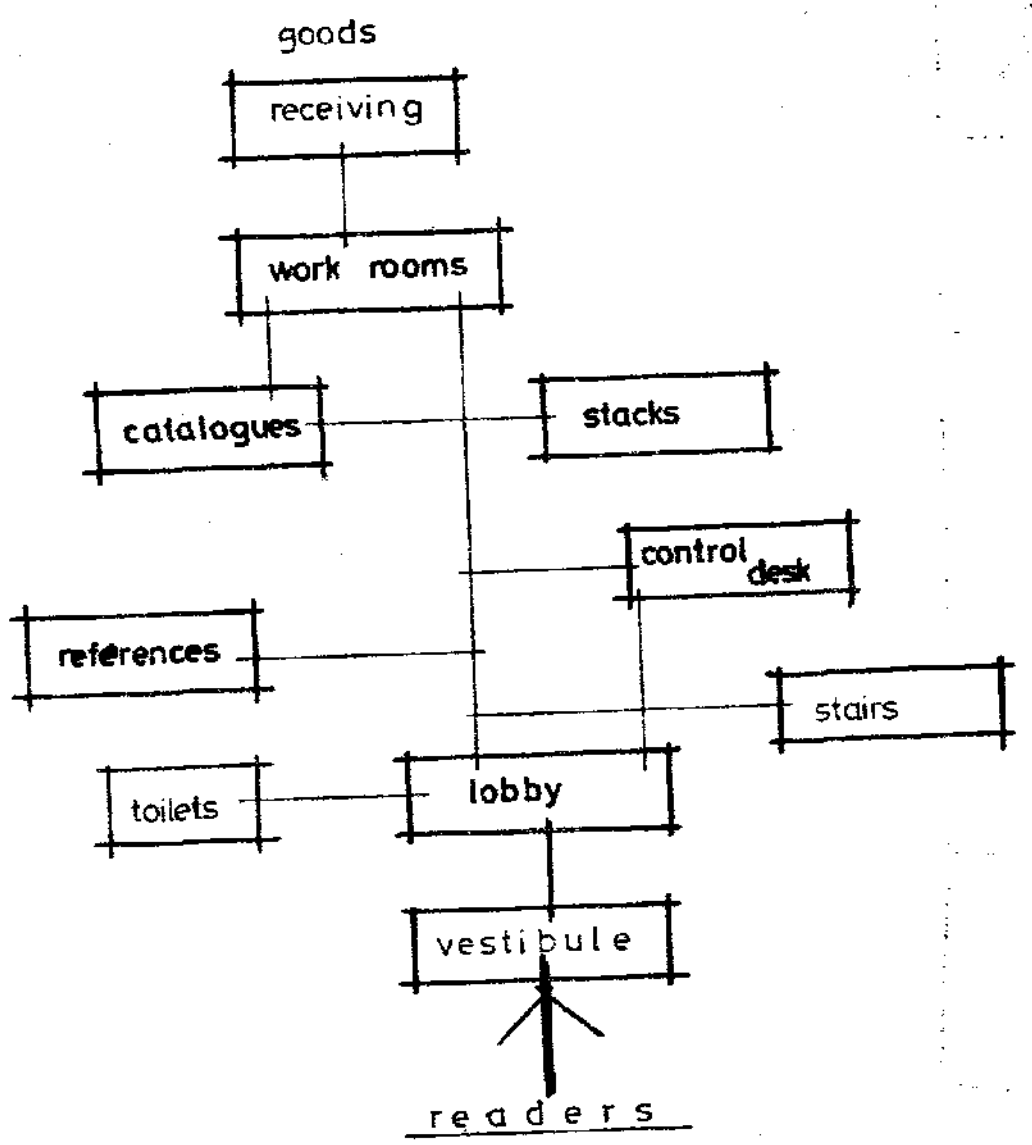
4.1.01 ADMINISTRATION: SCHEDULE OF ACCOMODATION

(TABLE 1)

	DEPARTMENT	SPACE	ACTIVITIES	FURNITURE FITTINGS	SIZE (Area in M^2)	OCCUPANCY (No. of Persons)	REMARKS
(1)	ADMINISTRATION	MAIN ENTRANCE	Drive-in /Foyer				To be covered and made attractive.
(2)		ENTRANCE HALL	Entrance exhibition	Large wall surface and free floor area			-Exhibition could be fixed or variable. -Provide large area
			Reception	Desk/counter with telephone		2	-Provide Free area.
			Waiting area for visitors	Seats		Variable	- To be easily accessible to toilets
(3)		Director's office	Office - duty receiving visitors	- office table and chairs - small conference table and chairs	40 m^2	1	- To be accessible to board-room - To have own toilet facilities
			Personal assistant office		16 m^2	1	- To serve as reception to directors' office
(4)		Deputy Director	office -duty -receiving visitors	- office table and chairs	30 m^2	1	2 - times
			Personal assistant office	-office table and chairs	16 m^2	1 variable	2- times
			Clerical pool		30 m^2	5	shared
(5)		Board room	board committe) meeting conferences	conference tables and chairs		50 (min)	The board room should be integrated with the directorate with a possibility of link with the larger conference auditorium
			Ante-room				
			Coffee room				
			Toilet				

DEPARTMENT	SPACE	ACTIVITIES	FURNITURE FITTINGS	SIZE (Area in m^2)	OCCUPANCY (Not of person)	REMARKS
(6)	Head External cordination and Publicity	Office		$30m^2$	1	
		Office Personal assistant		16	1	
		Office Clerical assistant		30	5	Shared
		Information Bureau - Information officers and assistants			10	Large area for display, documentation and information retrieval
ADMINISTRATION (8)	Head Internal Admin.	Office	office table and chairs	30	1	
		Personal assistant office	office table and chairs	16	1	may be shared
		clerical Assistants		30	5	shared
		stationary store		30	2	
		Filing Registry		20		
	TOTAL			116 m^2	9	
(9)	Head, Finance office	office	office	30 m^2	1	
		Deputy Finance officer	office	30 m^2	1	
		Accounts officers		16 m^2	x3	3 no
		General Accounts office		30 m^2	5	shared
		storage		16 m^2		
		AUDIT Office	office	20 m^2	1	
		clerical Assistant		20 m^2	3	shared
	TOTAL			192 m^2	16	

(17)	Conference Auditorium	main seating		300 m^2	300 - 500	- Possibility to be used for both small and large meetings. - should be close to the directorate - should have a projector room and audio-visual control room - should have a press gallery
	TOTAL			300m^2 (Min.)		



FIG· 34

LIBRARY

flow diagram

4.1.02 ANCILLARY FACILITIES: SCHEDULE OF ACCOMODATION

DEPARTMENT	SPACE	ACTIVITIES	FURNITURE FITTINGS	SIZE (Area in m^2)	OCCUPANCY	REMARKS
(1) Publication Unit	officer			16m^2	1	
	Assistants			20m^2	2	shared
	Dark rooms			30m^2	3	shared
	Drawing office			28m^2	2	shared
	Production roon			110 m^2	3	
	store			16 m^2		
	Toilets					shared
	TOTAL			220 m^2	11	
Computer Unit (2)	officer			20 m^2	1	
	assistants			28 m^2	3	shared
	Ancillary rooms			100 m^2	4	
	Computer Room			100 m^2		
	Machine room			24 m^2		
	store			24 m^2		
	engineer			20 m^2		
				308m^2	8	
Television Unit (3)	Officer			20 m^2	1	
	assistants			30 m^2	3	
	studio			80 m^2	3	
	control room			20	2	
	engineer			16	1	
	Library			80	1	
	store			10		
	TOTAL			256 m^2	11	
Library	Admin	office		30 m	3	Shared
	workroom			54	variable	
	Books/readers		carrells -stacks	147	50	
	Store			50		
	Bindery			176	10	
	Toilets			36		
	TOTAL			1750 m^2	steff 18	
Staff Canteen (5)	Dining			192	(diners) 120 - 150	shared
	kitchen			192		
	storage					
	loading					
	Toilets					
	TOTAL			384 m^2	staff = 10	

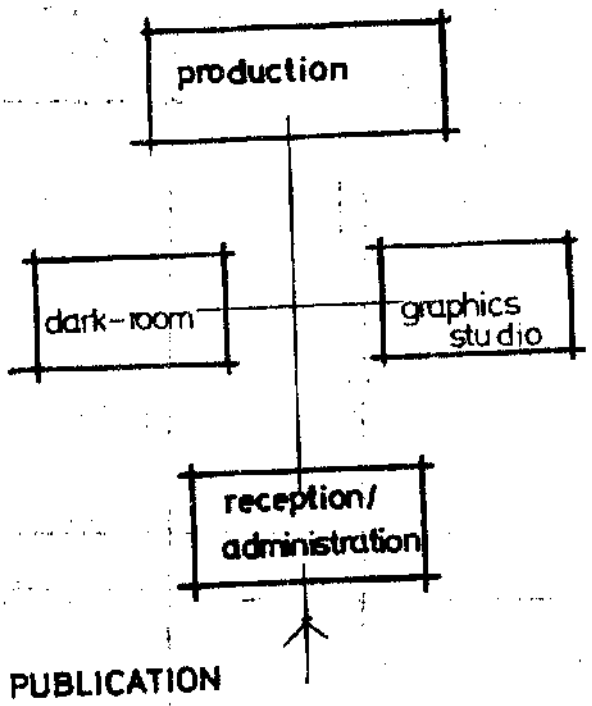


FIG. 35 PUBLICATION

flow diagram

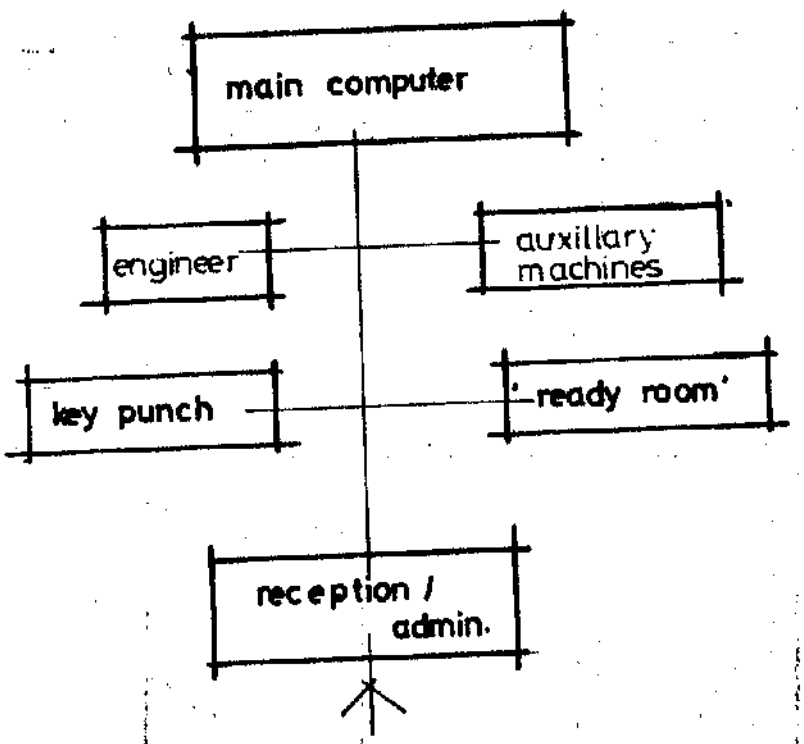
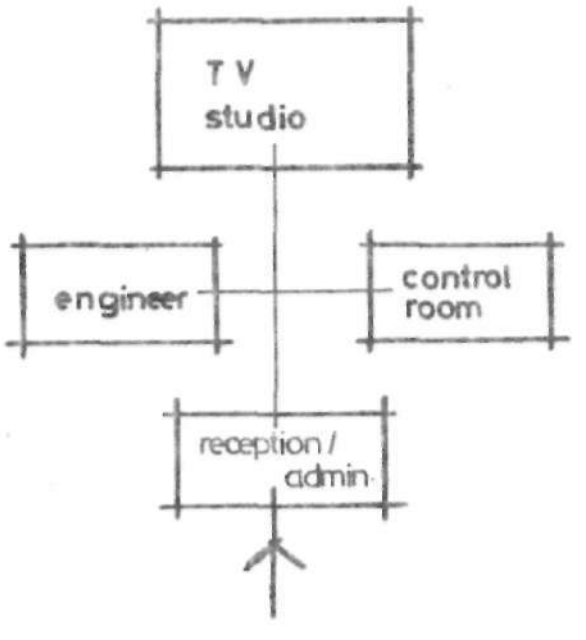
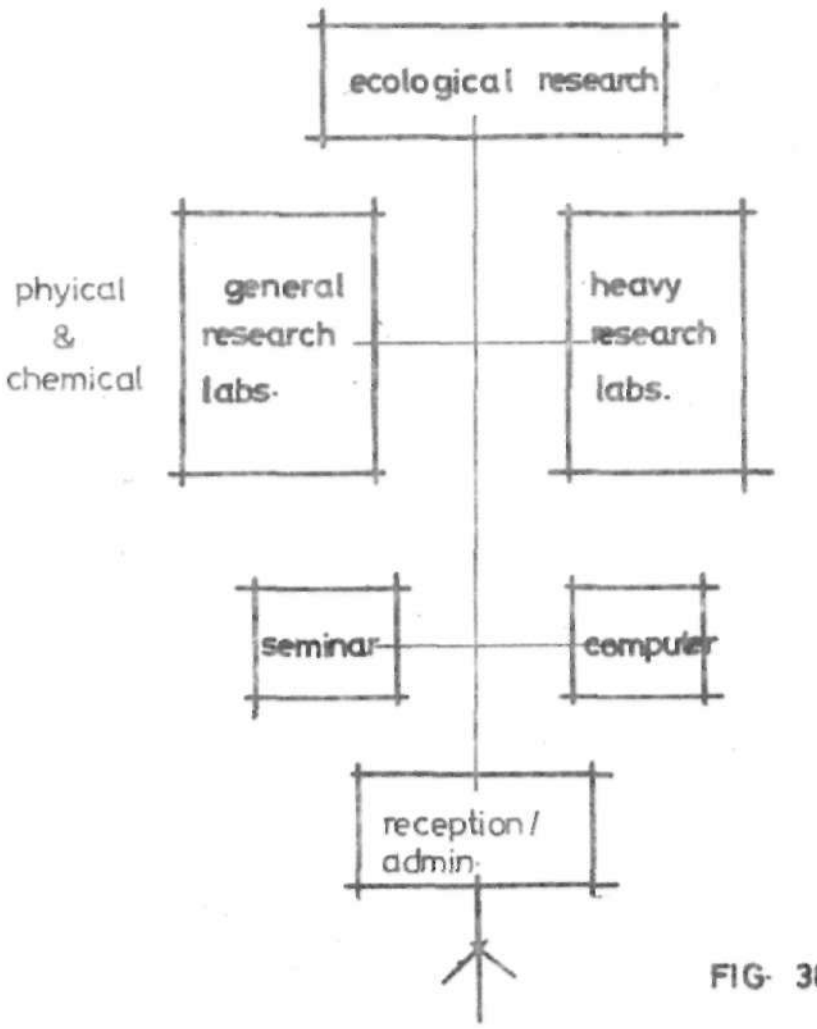


FIG. 36 COMPUTER UNIT

flow diagram



FIG· 37 TELEVISION UNIT
flow diagram



FIG· 38 RESEARCH AREA
flow diagram

Table 5

4.1.03 RESEARCH FACILITIES : SCHEDULE OF ACCOMMODATIONS

DEPARTMENT	SPACE	ACTIVITIES	FURNITURE FITTINGS	SIZE (area in m^2)	OCCUPANCY	REMARKS
Research (15)	Heavy Laboratory	- Experiments - Offices		512 144		
	Light Technical Laboratories	- Experiments - Storage		1950		
	General Laboratories			2,082		
	Special Laboratories			758		shared
	Laboratory offices			1,238		For the total scientific staff (see Table 12)
	Toilets Stores Services circulation			6,444		
	Seminar rooms			768		
	Library			128		

Note

(1) From Table 12, the grand total of staff in the Research section is 230

(2) From Tables 10 and 12 the minimum number of staff for the Research centre is 112 + 230 = 342

Table 4

BREAKDOWN OF RESEARCH PERSONNEL AND FACILITIES

(These are based on personal assumptions relative to existing personnel situations in some Nigerian Universities)

Research Section	PERSONNEL: Research consultants & Research fellows	Research Assistant: Graduates	Research Assistant: Technicians	Non-Scientific Assistants (clerks & cleaners etc)	FACILITIES REQUIRED: Project Research Teams	LABORATORIES: General	LABORATORIES: Special	LABORATORIES: Technical	W/shops	Offices	Seminar Rooms	Library
General Physical	Physicists, Geogolists etc 10	10	10	5	Sizes vary and are multi-disciplinary consisting of personnel from as many disciplines as required	x	x	x	x	x		shared
Physical - Technology	Engineers, Metallurgists 10	15	15	5			x	x	x	x		
Maths.	Mathematicians, Statisticians 10	10	5	3						x		
General Chemical	Chemists, Biochemists 15	15	15	8		x	x	x	x	x		
Chemical Technology	Chem-engineers, Chem. technologists, Industrial chemists 10	10	10	5			x	x	x	x		
Ecological	Biologists, Ecologists, Doctors 10	5	5	4		x	x	x	x	x		
Others	5	5								x		
T O T A L	70	70	50	30								

Summary of staff for Administration and
Ancillary facilities

TABLE 5

Section	Number of staff
Director and Deputy - Directors' office	13 (minimum)
External Co-ordination, information and publicity offices	17
Internal Admin. and Finance offices	25
Publication Unit	11
Computer Unit	8
Television Unit	11
Library	18
Staff Canteen	10
T O T A L	112

A detailed schedule of accomodation for this department is being left out since the detailed architectural design is being left out. However, in the general planning and site layout, it will be carefully zoned to make its effecient functioning and expansion possible.

The facilities for this department include the administrative offices for the head, his assistant and clerks. Other facilities include:

- a central store for dry and cold storage
- Instrument Repair shop for electronic, electrical, and mechanical appliances
- Automative Repair workshop for vehicles
- Woodworking Repair shop
- Paint workshop
- Building Repairs Unit
- Physical planning Division with office provisions for planner/ architect, engineer and draughtsmen.
- Petrol filling station for institutional use and staff.

The proposals for the "Services" are as follows:

Water Supply: The mains come from the Kaduna municipal supply systems that are close by.

Provision should be made for a central tank storage, while minor water supply tanks are located on all the buildings that are upto three or more storeys high.

Electrical Supply

The mains supply will be provided by the National Electric Power Authority (N.E.P.A.) stationed in Kaduna.

Provision should be made for the installation of an automatic stand-by plant for emergency and NEPA mains Power failure periods.

Hot water and Steam -

A central Boiler house is being proposed. Each laboratory building, however should have a plant room where emergency provisions could be met.

Refuse Diposal -

A central inciniration plant is being proposed

Gases, Vacuum and
compressed airsupply

A central depot is being proposed where supplies in cylinders are made to the laboratories where they are connected to the supply "runs" .

In the case of burner gas for which liquified natural gas could serve the pruposo, consideration should be given and expert advice sought on the possibility of mains pipeline supply from the proposed Kaduna Oil Refinery. Other gases, such as oxygen, nitrogen, the inert gases etc have to be supplied in cylinders.

Sewage disposal

A central sewage disposal plant is being propsed in lieu of public sewers. Wastes from the laboratories have to be specially treated before the effluents could be discharged into the public sewers or the sewage disposal unit.

Surface Water
Drainage

The natural drainage of the land would be expcited and to be augumented by drainage channels.

4.1.05 Housing Accomodation

Housing for guests on the site comprises about sixty double bedroons suites served by a kitchen - dining and laundry facility complex which could also serve as a "social centre " for the senior staff of the proposed centre. When "guests" are more than the sixty bedroons provided, alternative accomodation would be arranged for them in nearby hotels.

The staff housing within the site of the proposed centre could be minimal especially as some of the sorrounding areas are zoned for residential use by the Kaduna Planning authorities.(see Kaduna, Land use Ma The majority of the junior and intermediate staff could then live in adjoining housing estates.

Though the emphasis of this scheme is on the central core complex of administration and research facilities, a possible residential area would be shown on the site-layout plan, living room for expansion.

4.1.05 Recreational Facilities

A soccer pitch and some lawn tennis courts would be provided for outdoor recreational purpuses. The "social centre" in which the guests accomodation will be provided would comprise indoor recreational facilities as well as provisions for other forms of relaxation like drinking bars.

GENERAL PLANNINGS PRINCIPLES

4.2.00 Taking into consideration the nature of scientific research work, the following PLANNING PRINCIPLES and PROPOSALS are made to provide the guidlines for the design of the Research Centre:

PRINCIPLE 1 :
Concentration of similar activities into functional sub- Complexes.

PROPOSAL :
Overall zoning of the entire site into functional and interelated areas according to noise levels; degree of privacy required and any other environmental consideration such as wind- directions.

PRINCIPLES 2:
Maximum close communication between the individual functional areas of the centre with minimum vehicular traffic hazard and to maintain the tranquil environment necessary for research work.

PROPOSAL :
(a) Development of a completely pedestrian intra-centre traffic with no through or cross vehicular traffic.
(b) Development of multiple cul-de-sac vehicle accesses to all parts.

PRINCIPLE 3:
Maximum expansion possibilities with minimum disruption of vehicular accesses to all parts of the centre.

PROPOSAL :
(a) Fix the peripheral distribution road from which cul-de-sacs are taken to "feed" the functional parts in an orderly pattern.
(b) Start building from the vehicular free "linear core" while expansion and future extensions would take place "outwards" towards the peripheral distribution road.

PRINCIPLE 4.
Maximum Orientation to reduce solar control problems.

PROPOSALS As much as possible, Northernly or southerly orientation for long sides of buildings.

PRINCIPLE 5

Zoning of facilities with due regards to prevailing wind directions.

PROPOSAL, The prevailing winds (Kaduna): the south-West and the North-East Trades are to be used to best advantage or least disadvantage, respectively.
For example, the desirable south-West breeze should be allowed to "breeze" through all parts, whereas it must be ensured that neither of the prevailing winds passes through the Laboratories before crossing the residential area.

PRINCIPLE 6:

Zoning of facilities to eliminate or reduce the problems of noise and vibrations due to heavy traffic.

PROPOSAL

The most quiet desirable areas of the research laboratories should be farthest from heavy vehicular interference of the highways or railway line.

ZONES	SUB ZONES		ACOUSTIC CHARACTERISTICS
	institutional	non-institutional	
public APPROACH	GATE HOUSE transitional DRIVE		serene
max SEMI PUBLIC	ADMINISTRATION auditorium information bureau	RESIDENTIAL	QUIET
min. SEMI PUBLIC	ancillary library publication	facilities welfare facilities MAINTENANCE	QUIET may generate own noise
PRIVATE	RESEARCH laboratories	stand-by plants	QUIET may generate own noise

FIG. 39 FUNCTIONAL ZONING OF FACILITIES

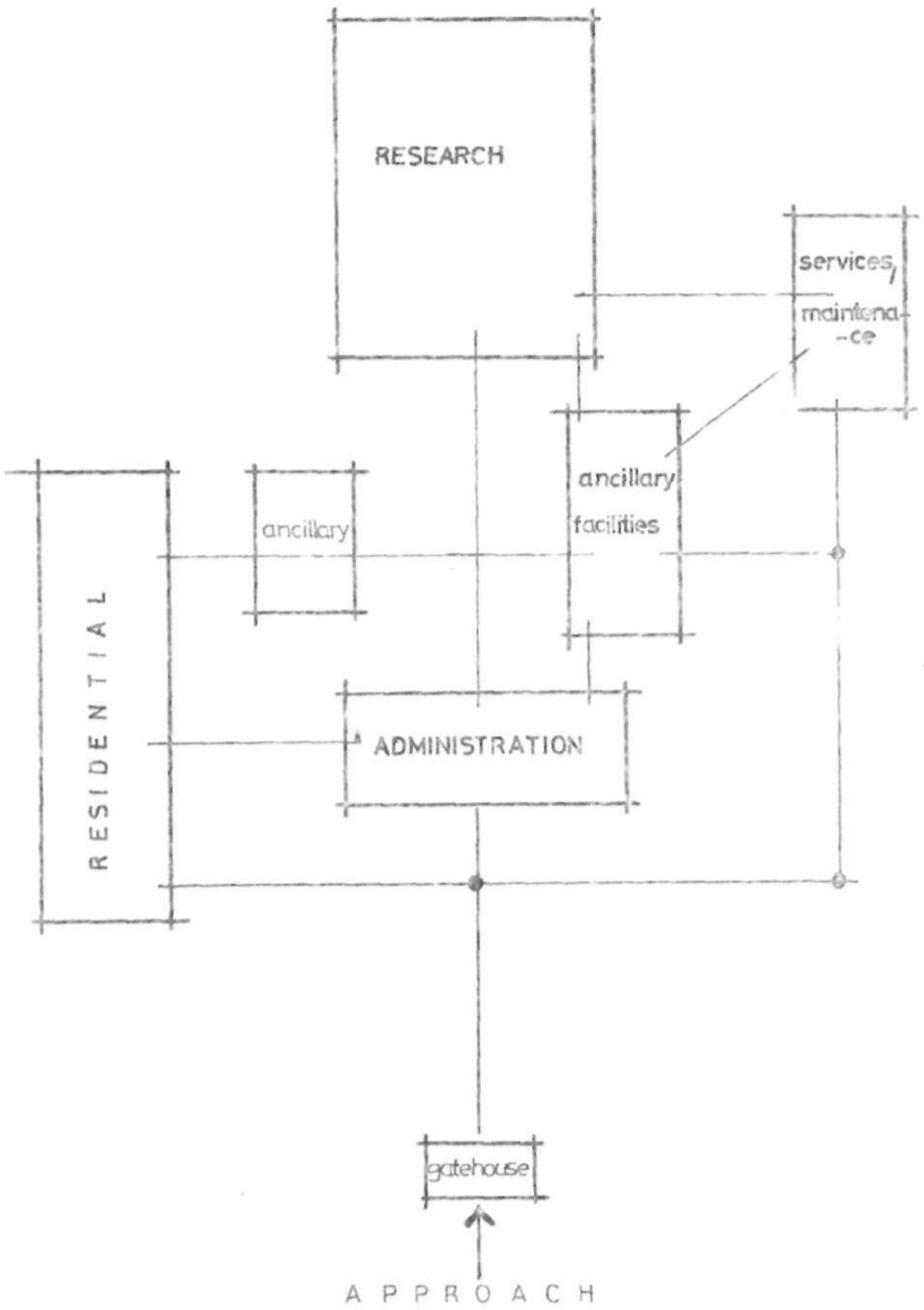


FIG 40 SITE FLOW DIAGRAM

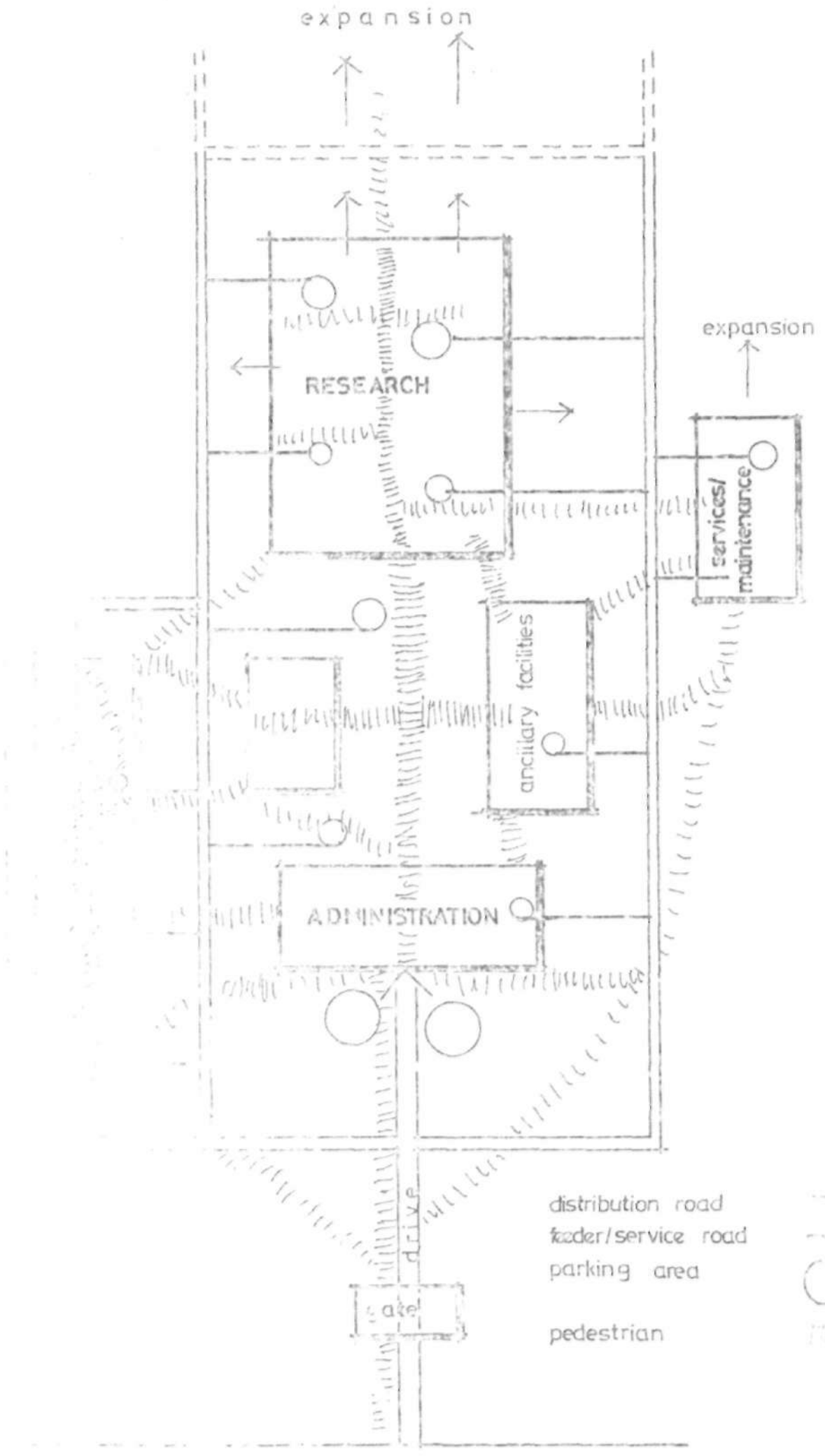


FIG. 7 CIRCULATION PRINCIPLES

ESTABLISHING THE DESIGN MODULES

3.00 It could be said that the laboratory area of a scientific research centre is the most important part of the centre. The laboratory area not only comprise of laboratories but offices for scientific staff as well. It goes without saying then that a module established for the laboratory area could be adapted for office planning as well.

3.01 The Laboratory Module or Unit

From studies of research laboratories it is recommended that the laboratory unit should comprise of straight benching. Having two parallel bench runs in a unit there is a need for a clear circulation space between them, for the workers to freely move and work. The module used for the design is 4000mm (see fig. 42). This allows for a minimum of 2000mm clear space between the benches. (see fig. 12)

3.02 The laboratory building layout.

Using the established 4000 mm grid an off-centre corridor building layout is being proposed for the laboratory building. (see fig. 43). The laboratory units occupy the deeper rooms on one side of the circulation corridor while the offices for the research personnel occupy rooms. The offices are grouped on one "bank" of the corridor separate from the laboratories to make sure that the well "serviced" deeper rooms are economically used for research purposes exclusively.

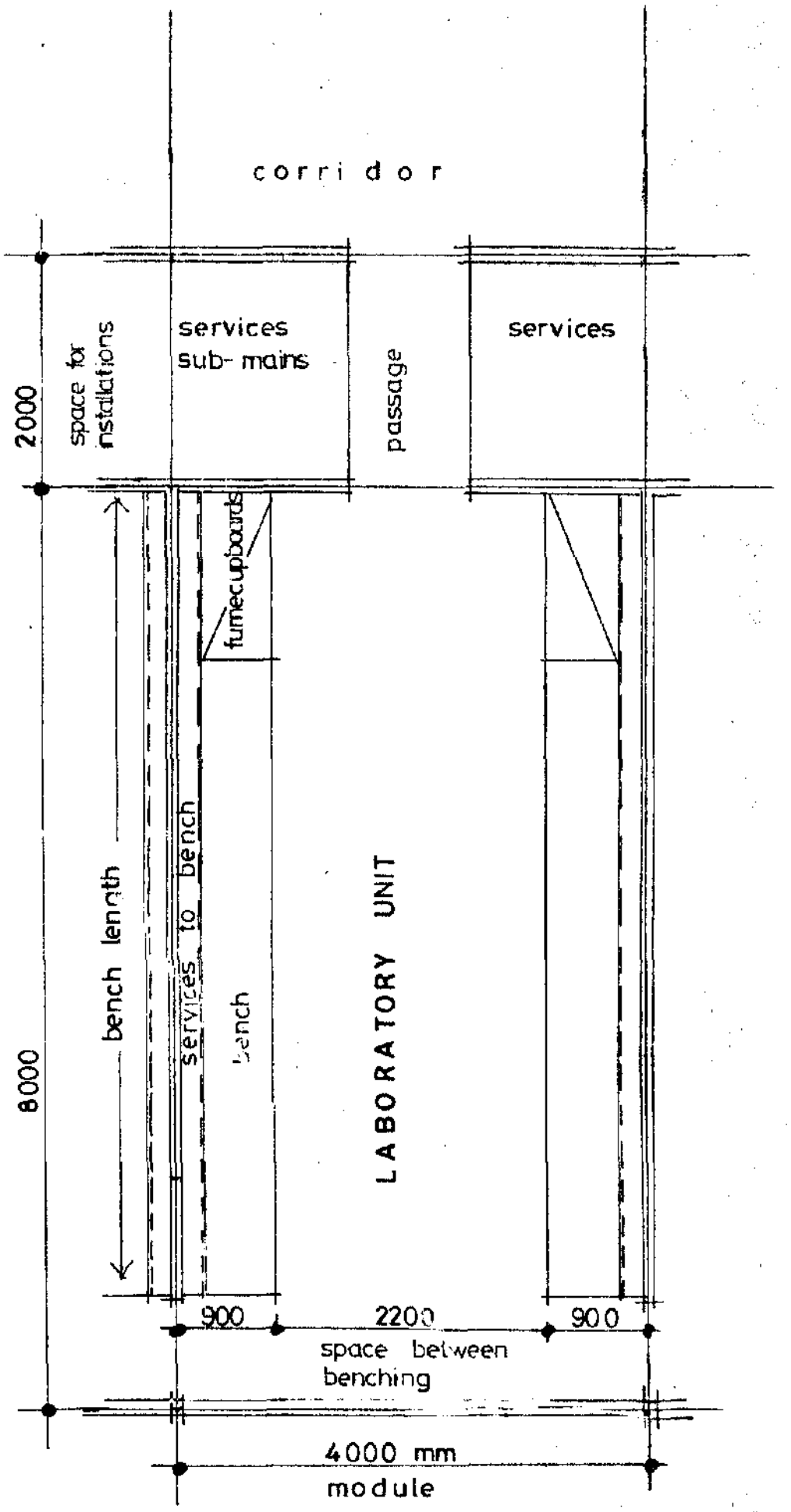
Laboratory Services Distribution System.

The services to be catered for in the design include cold water, hot water, distilled water, steam, burner gas, inert gases, oxygen, compressed air and electricity.

The distribution system comprises of the mains, the sub-mains and the laboratory unit distributions.

The distribution system used in the design is based on a Horizontal mains at a low level with vertical submains distribution upwards to service laboratory units at each floor level. (see figures 44,46, Refer to figs. 31,32,13, - 23)

The horizontal mains are located at first floor level in a continuous "service corridor accessible through out its entrie length making inspection of all the services possible form the circulation corridor at first floor level. From the horizontal mains vertical sub-mains are carried up in services shafts at each laboratory module.



FIG·42 ESTABLISHING DESIGN MODULE FOR LABORATOF

(see fig 12)

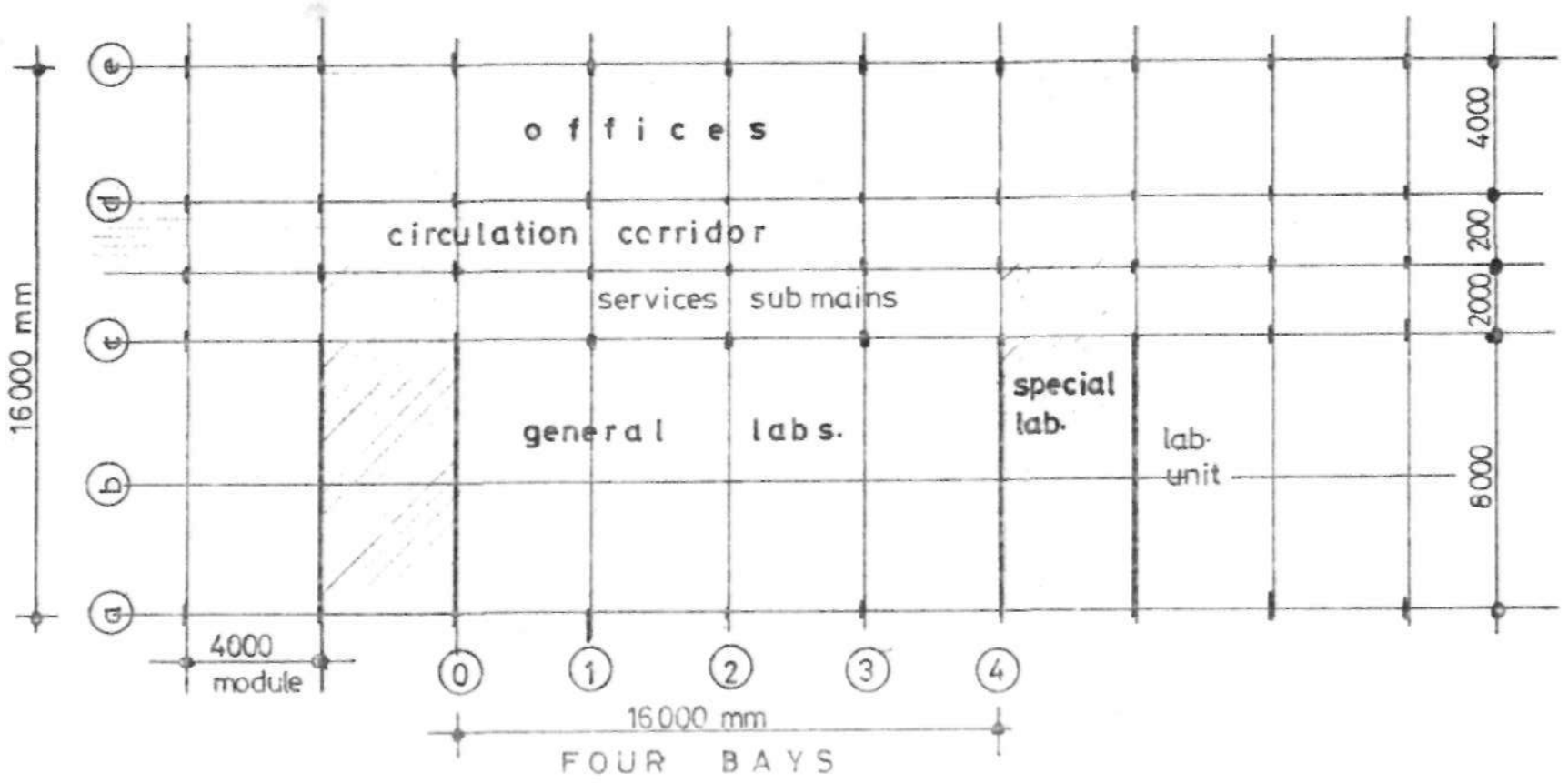
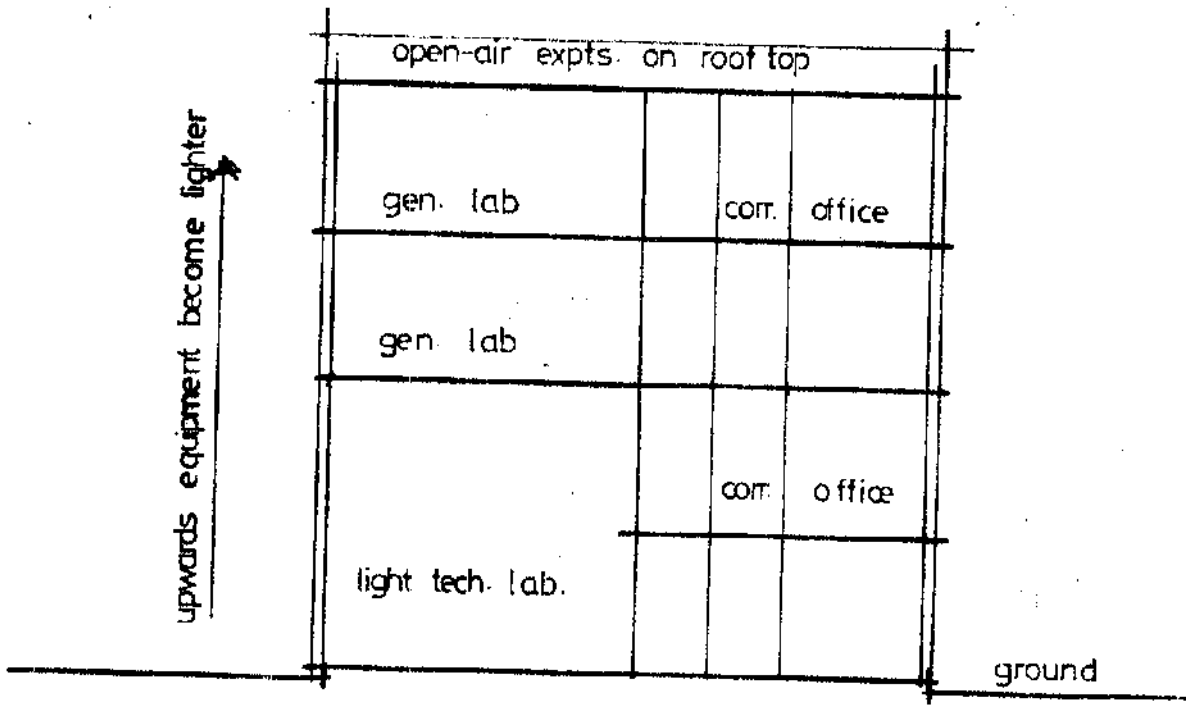
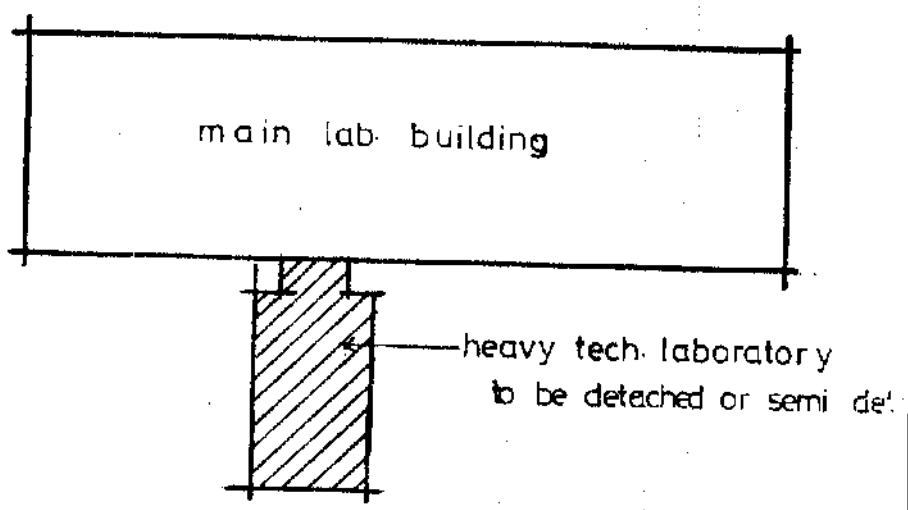


FIG 43 Establishing relationships between laboratory rooms
(using off-centre corridor layout, see fig 24)



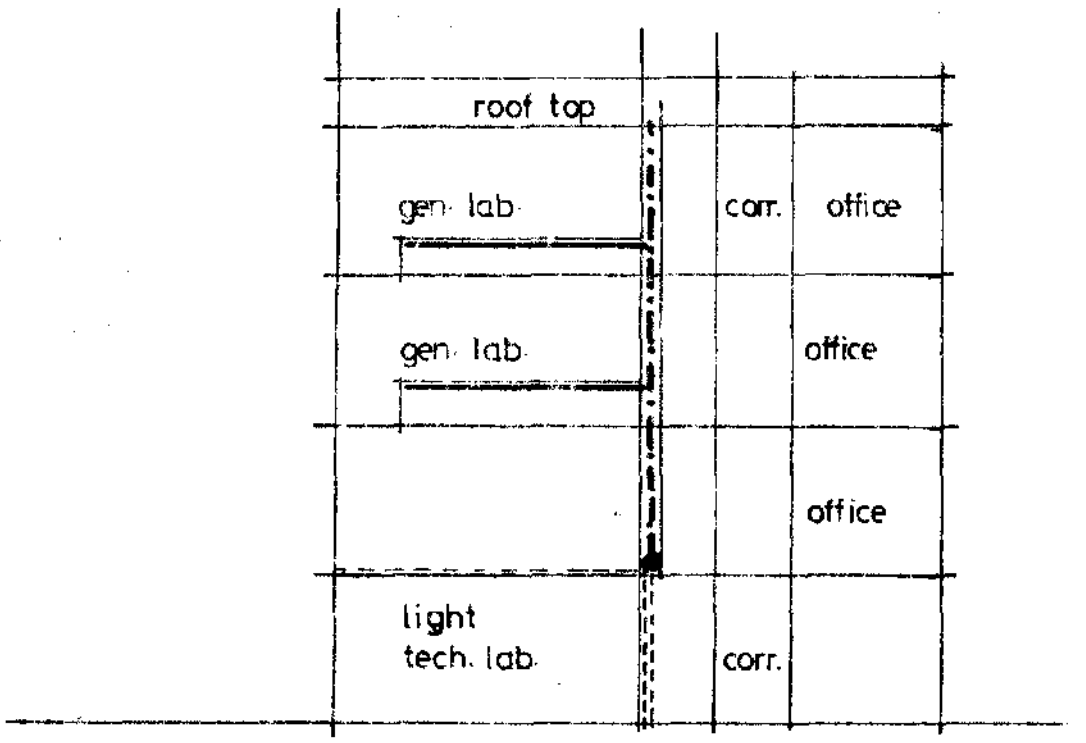
diagramatic section

FIG. 44 HEIRARCHY OF LABS. IN BUILDING

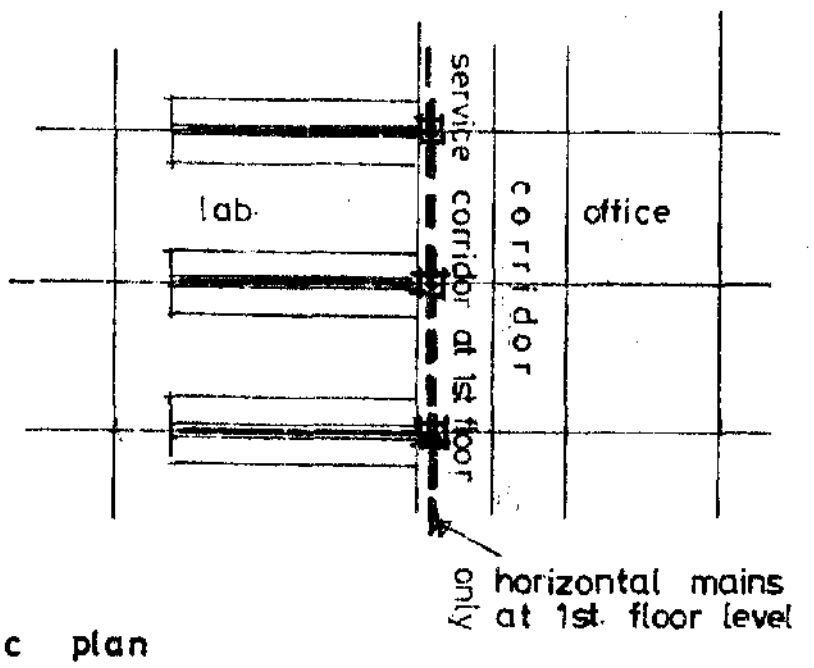


diagramatic plan

FIG. 45 POSITION OF HEAVY LABS.



diagramatic section



diagramatic plan

FIG. 46 SERVICES DISTRIBUTION PROPOSED

(vertical sub-mains from a horizontal main at first floor level in a service corridor)
see figs 17 - 23

. Each of the services shafts are accessible from the circulation corridor of each laboratory floor (see Example Fig. 32)

4.3.04 Hoirarchy of laboratories

There are two general categories of laboratories designed for: the general research laboratory and the technical laboratories which are workshop type and require heavier equipment and higher head-room. The light technical laboratories with high/floor. / high headroom are located on the ground ——— The general research laboratories are located on the upper-floors. The roof top could also be used for open air experiments in solar energy, telecommunication etc. Heavier technical laboratories are either completely detached or semi-detached of the main laboratory building (Figs. 44, 45)

.3 05 Planning for growth

Consideration for expansion and growth is crucial and need to be planned for. Consequently a concept of the "growth unit" is used in the design. The growth unit is composed of a square of four bays of the laboratory module. The laboratory module is used as the controlling grid as well as the link or separation bay between the growth units. The resulting growth is composed of 16x 16 m square units linked by 4m bays. (see Fig. 47).

The principle of growth units is applied generally in the overall site planning for the proposed research centre.

.3.05 Features

Generally, no building is more than four storeys high. The Administration block has three levels of floors serviced by a central staircase. The laboratory blocks have up to four levels of floors including the ground floor. Vertical circulation in the laboratory blocks are by means of staircases and lifts. The lifts became most useful in moving goods.

It is proposed that each block or a simple combination of blocks be serivced by a central air conditioning system.

PLANNING FOR GROWTH

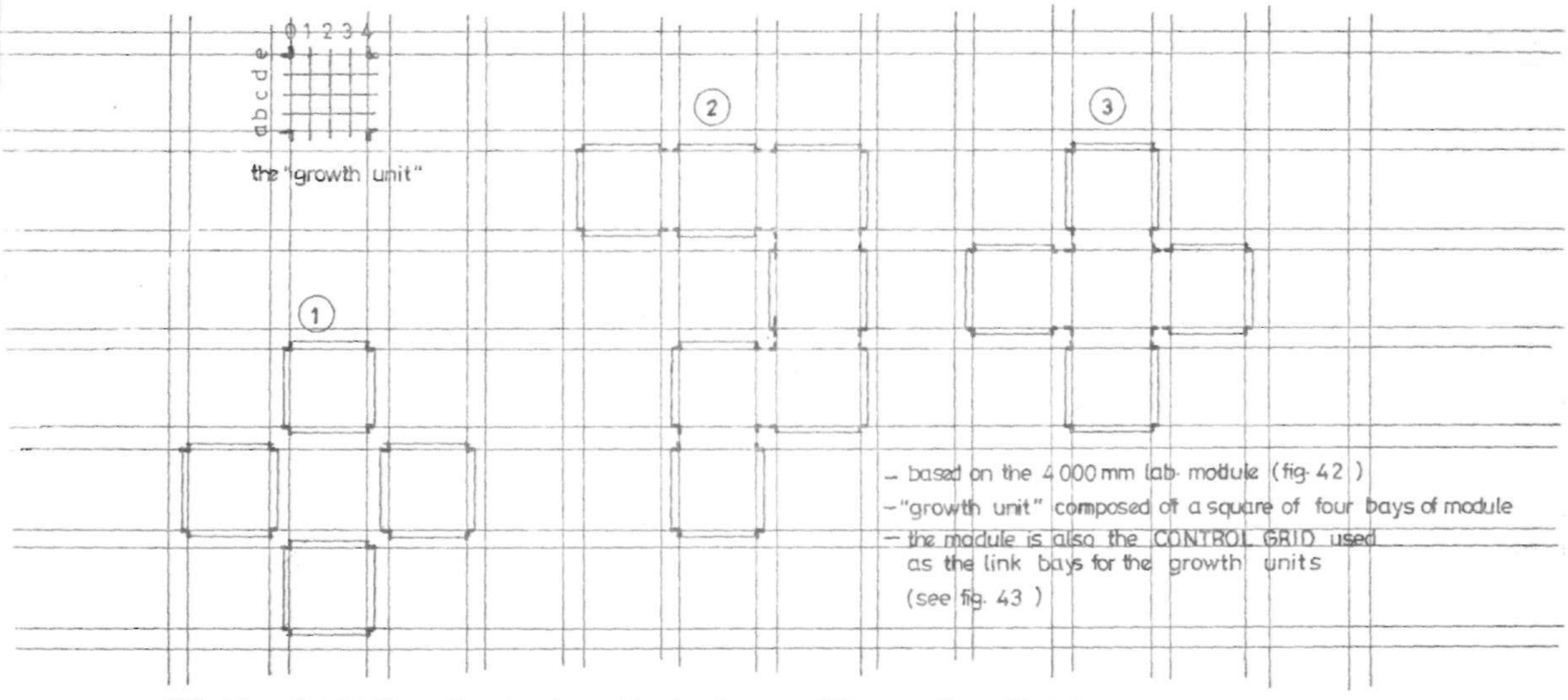


FIG. 47 Establishing site planning grid showing possible growth patterns

The laboratories have extra ventilational requirements especially in dealing with fumes. Extract ducts are located within the services shafts with extract fans at the top of the laboratory buildings.

Though a staff canteen is provided, kitchenett facilities are provided on each laboratory floor to be used by laboratory workers who may need to stay within the laboratory premises for a long time. Lounges are also provided between the laboratory offices for informal discussions.

The Administration area in the design is composed of "bionorphic" forms while the laboratory area is composed of more "architectural" forms.

THE SITE IN KADUNA

4.4.00 In chapter 5 of Part II of this text, above, the considerations which led to the eventual choice of Kaduna as the area for the location of the Research centre being proposed were discussed. This chapter deals with the precise physical location in Kaduna.

The site selected as indicated on the Land-Uses map shown in Figure 48 is within a green belt zone south east of Kaduna. The site is just outside the Eastern Highway wing of the proposed Ring Road round Kaduna.

The factors which influenced the selection of that site are:

(i) Easy accessibility by road from the New Federal capital in particular and from other parts of the country in general. Being located outside the ring road it would be easy to reach the site without going through the town.

(ii) Freedom from atmospheric pollution, noise and vibrations due to heavy industry. The site is not only in a green belt and away from industrial zones but situated at such a place that non of the prevailing winds pass through any industrial area before reaching it.

(iii) Expansion possibilities is very crucial for the selection of any site for research activities. The site selected is within a large expanse of land and expansion is virtually unlimited.

As can be seen from the Land-Uses map the closest planned zone to the selected site are for residential uses. Residential accomodation for the staff could easily be found not far from the site, even if they are not provided within the site.

The site is a naturally well drained-generally "flat" land. The proposal made covered an area of approximately 30 hectares. The site is accessible from the Eastern Highway. There are no physical constraints.

Figures 49 - 53 show standard solar chart and solar angle diagrams for Kaduna. The solar control, the prevailing winds, rains and temperature (discussed in part II above) constitute the environmental determinants. As much as possible the orientation of most buildings are such that northern or southern exposures are achieved.

(yet unpublished)

PROPOSED MASTER PLAN FOR LAND USES 1990

per kindness of

KADUNA PLANNING AUTHORITY

to Kaduna intern. ai

to Lagos

r. Kaduna

WESTERN HIGHWAY

EASTERN HIGHWAY

N

Site for proposed research centre

to Kafanchan

Proposed A2 to Warri thru new Fed cap

to Lagos

to Kafanchan

1 : 100 000

FIG. 48 Kaduna land uses map

- commercial
- industrial
- residential
- govt. uses /utilities
- educational
- intra urban green areas
- forestry reserves
- major roads
- rail alignment

10° N

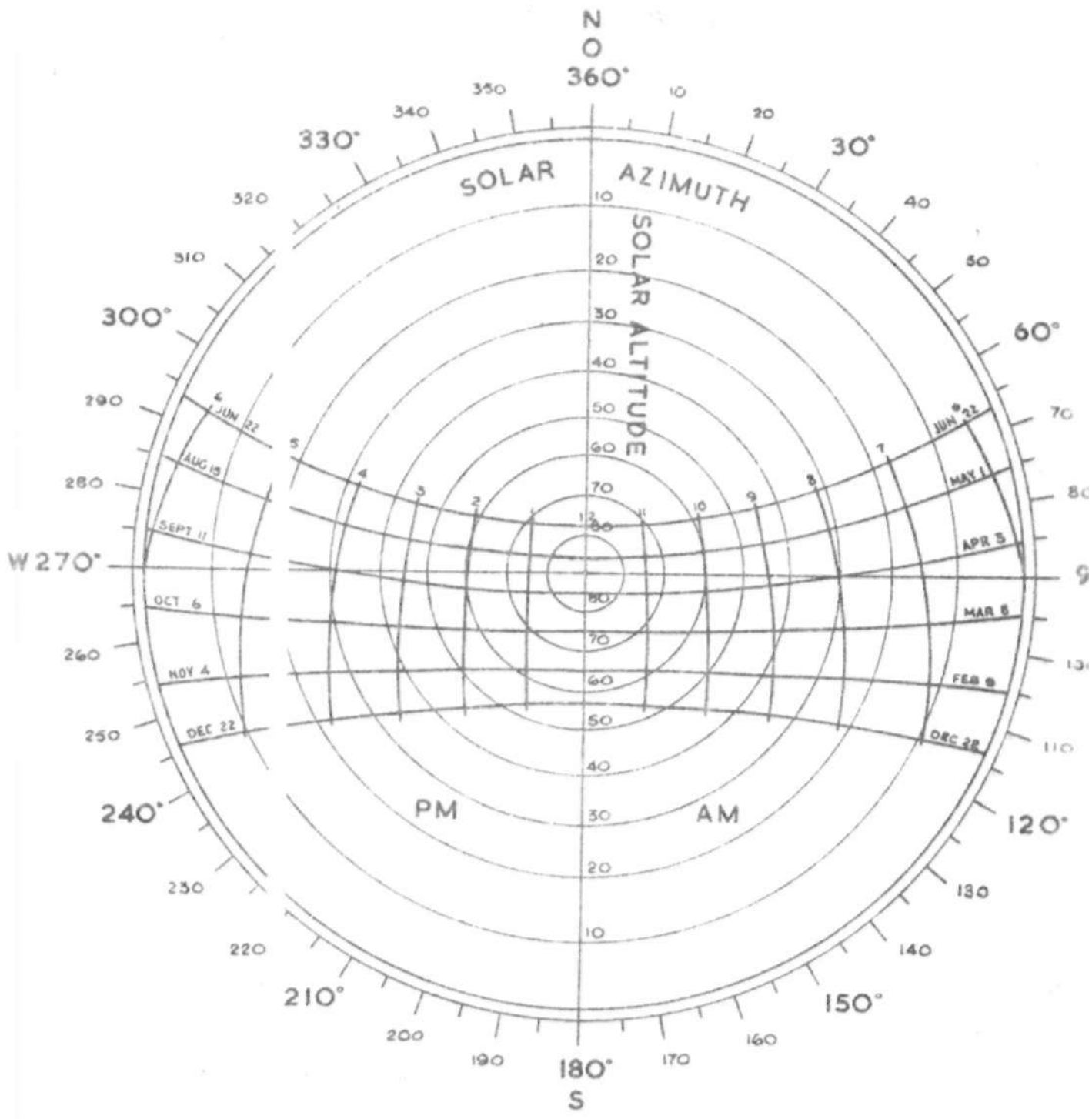
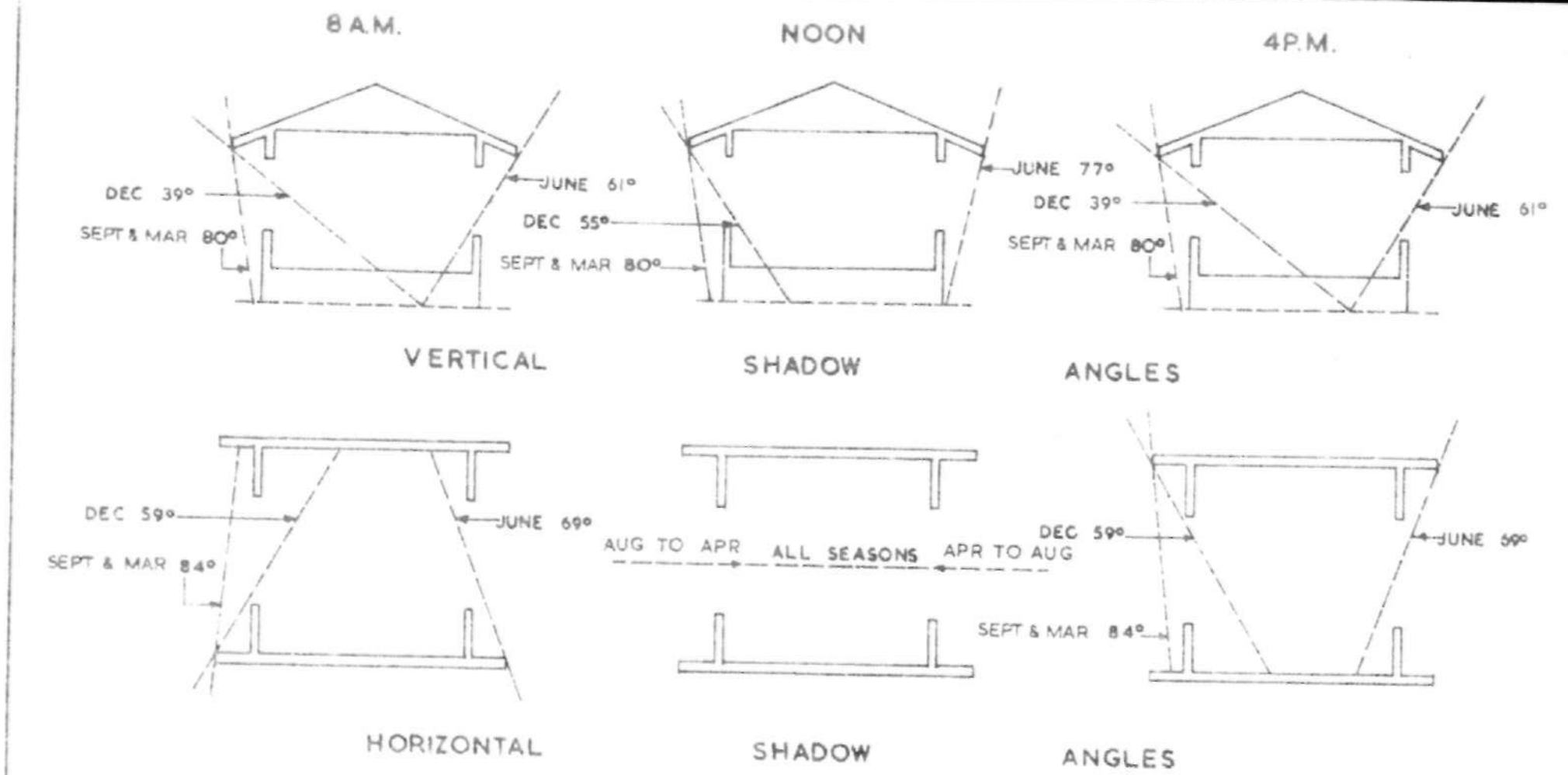


FIG. 49 Solar Chart for Latitude 10° N

applicable to kaduna



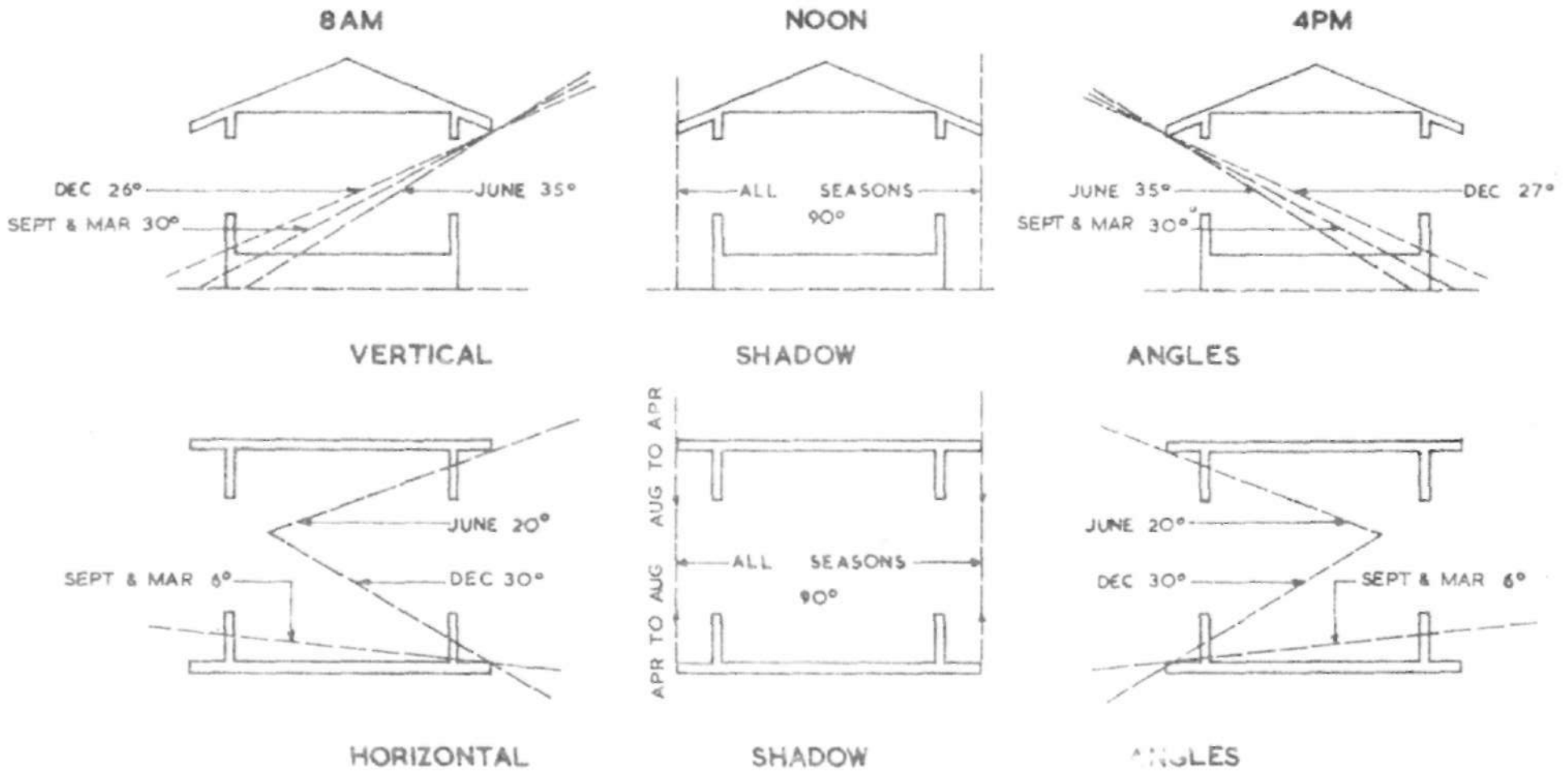
NOTE :—
THE TIMES ARE LOCAL SOLAR TIMES CORRESPONDING TO THE LONGITUDE OF THE TOWN

APPLICABLE TO :— KADUNA

LATITUDE 10° N

S ⟷ N

FIG 50



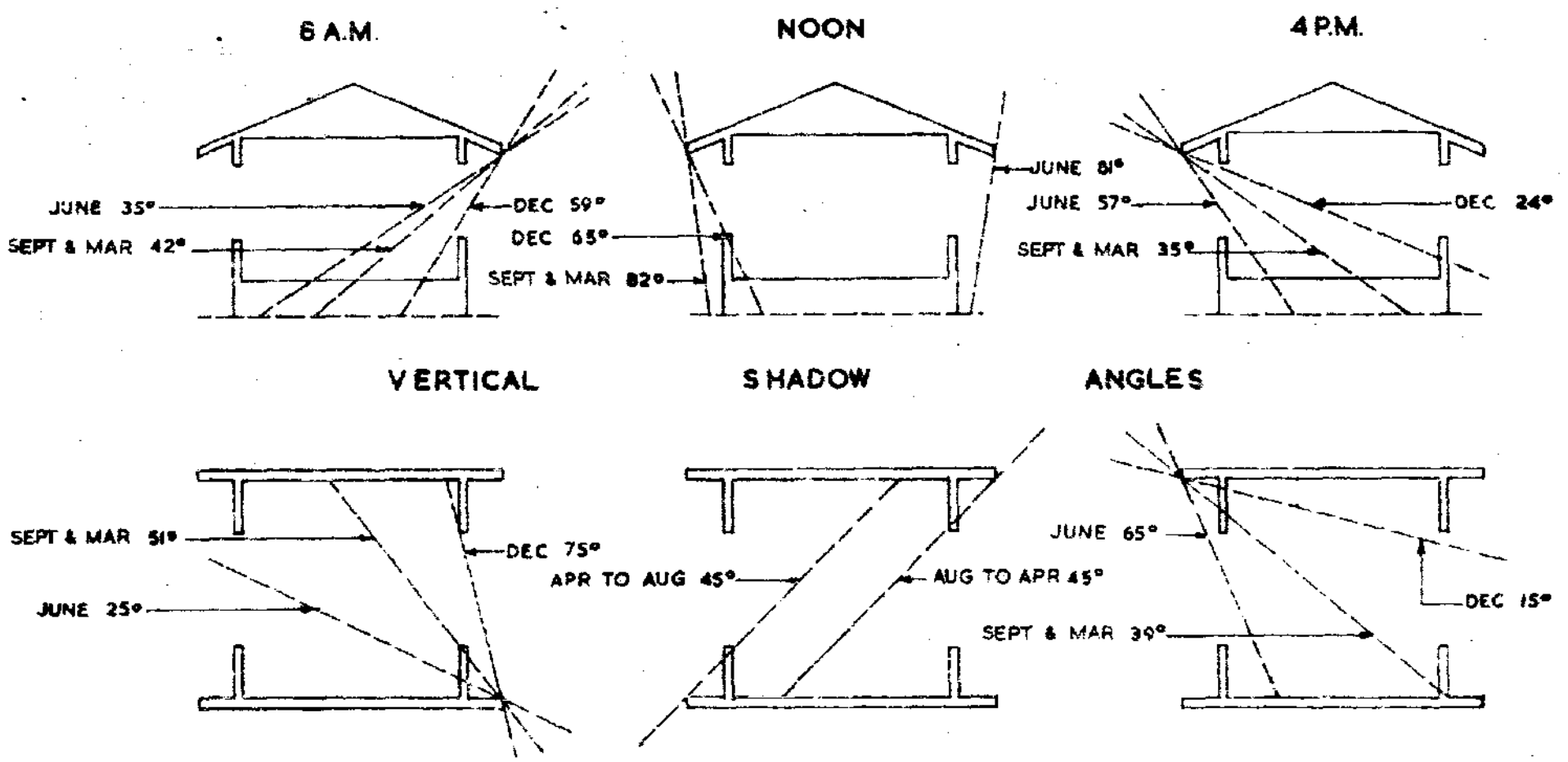
NOTE :—
THE TIMES ARE LOCAL SOLAR TIMES CORRESPONDING TO THE LONGITUDE OF THE TOWN

APPLICABLE TO :— KADUNA

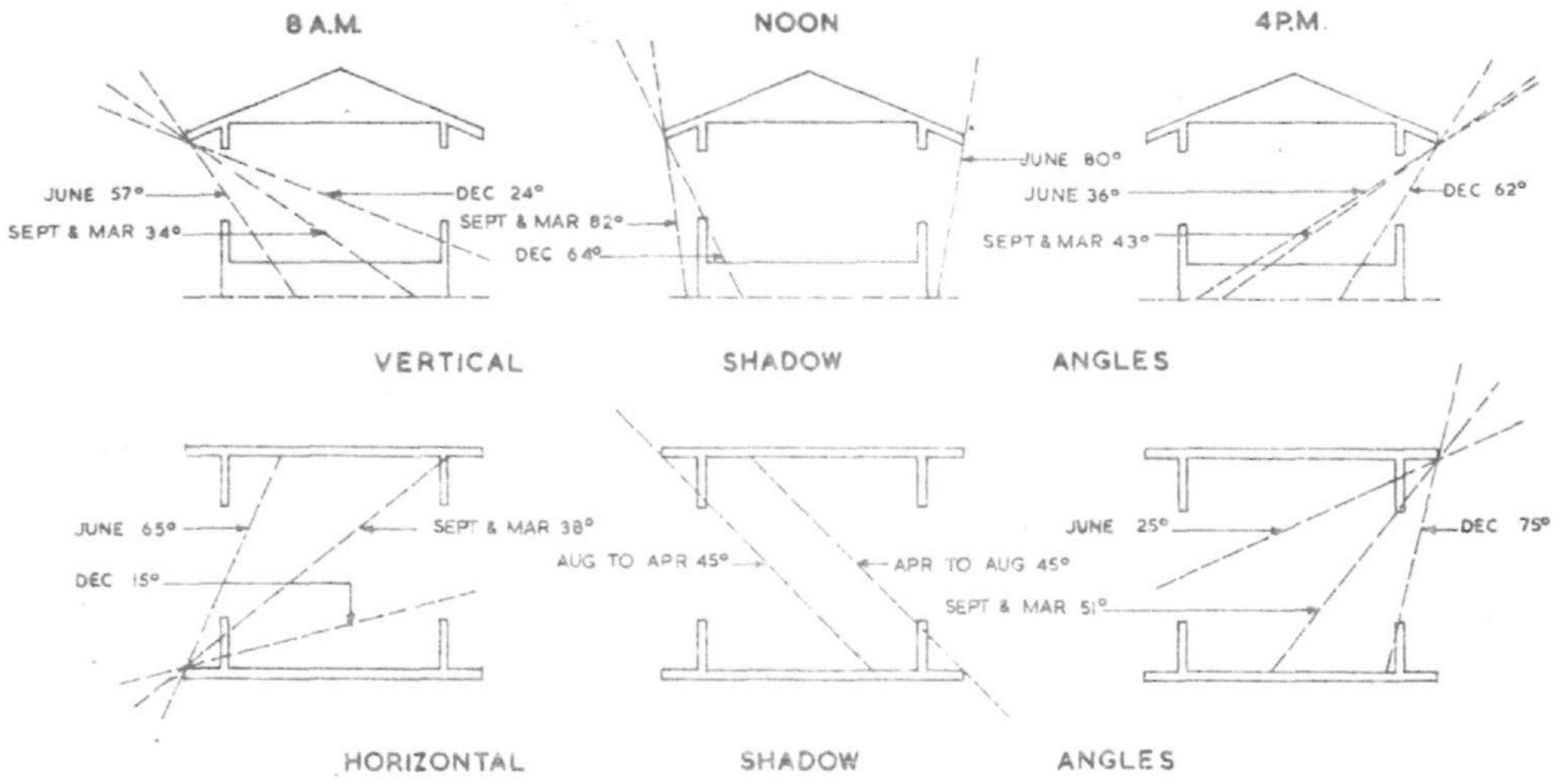
LATITUDE 10° N

W ⟷ E

FIG. 51.



NOTE:— THE TIMES ARE LOCAL SOLAR TIMES CORRESPONDING TO THE LONGITUDE OF THE TOWN	APPLICABLE TO:— KADUNA	LATITUDE 10° N SW ⟷ NE	FIG. 52



NOTE :— THE TIMES ARE LOCAL SOLAR TIMES CORRESPONDING TO THE LONGITUDE OF THE TOWN	APPLICABLE TO :— KADUNA	LATITUDE 10° N SE ⟵ ⟶ NW	FIG. 53

ARCHITECTURAL CHARACTER OF DESIGN

5.00 From the planning point of view one major consideration is the problem of expansion or growth. Using the grid system outlined above some pattern of growth was established. The creation of varied sizes of enclosed and semi-enclosed courtyards were to give a non-monotonous experience. On the whole, by the nature of the institution of a research centre of the scope proposed, it is imperative for a unique (if not symbolic) image to be created.

5.01 The Aim is a "strong" and " imposing" Architecture with clear and complimentary identities for the two main institutional functions of the Research centre - the Research and Administration. Attention was given to the Main Entrance being the symbolic link and bridge with outside world.

5.02 A water tank located within a courtyard in the Research area is the tallest structure and therefore a land mark on the site.

5.03 Structures:

The concept of "Free Span" is used throughout the main institutional buildings. Using an in-situ reinforced concrete frame, the floors and roofs are of reinforced concrete "space-deck" construction using post-tensioned and pre-stressed - precast reinforced concrete lattice grid. The main advantage of this system is the "free - space" of about 16 m centre to centre which can be flexibly partitioned and used both in the laboratory, administration or seminar buildings. Flexibility and adaptability in use of spaces are very suitable concepts to guide the provision of spaces for rooms in a research centre where activities changes frequently as research programmes change.

5.04 Addendum

The use of the structural "Space-dock" mentioned above was eventually restricted to the construction of the seminar blocks, whereas, conventionnl reinforced concrete floor slabs were used for the other buildings.

PART V

C O N C L U S I O N:

The Theme of this thesis is "National Centre for Scientific Research and Development" - being a hypothetical contribution to the promotion of Science and Technology in Nigeria with due considerations to the needs of the nation. The proposal being made is the establishment of an Interdisciplinary Research Centre with emphasis mainly on non-life Natural Sciences and their corresponding Applied Sciences and Technology. The ecological implications of the research activities would be catered for by providing correlational ecological research facilities.

The design was aimed at providing a complex of interelated laboratories, workshops and offices and other ancillary research facilities to meet a wide range of research programmes in general physical and chemical sciences and technologies,. Being not directed to specific and restricted uses, the design of laboratories and offices had of necessity to be highly flexible and adaptible to changes to meet the changing requirements of research programmes. Because of the more special safety, structural and services requirements of nuclear and atomic research it is being suggested that a separate Atomic Research Institute be established to complement the rather general Interdisciplinary Research Centre being proposed. Consequently, special attention to atomic and radioactive laboratories was left out in the design scheme.

The importance of planning and designing for flexibility, adaptability and expansion need not be overemphasized; but it could be said that next to the efficiency of the services distribution system, the factors of adaptability and growth pose as the tests to the success of the design of any scheme for research purposes. In fact the flexibility of the services distribution system could be termed test number one.

In real life - design situations, a high level and detailed architect - scientists' relationship is imperative so th t the best provision could be made in terms of the specifications of installations, fittings and even finishes.

Consequently this scheme which is highly hypothetical is an attempt to evolve a workable and functional planning for a research centre and to produce a sketch or preliminary architectural design with the emphasis on the principles rather than very specific details of design.

The design of Research laboratories is a new field in Nigeria and in most developing countries. It would be of interest to know of any design features that could be peculiar to the design of research laboratories in the tropics. Certainly, if universal scientific methods and procedures of research are to be followed then conditions for the efficient use of equipment have to be controlled. Almost invariably, the desire by scientists to have quiet, vibration free, dust free, controllable thermal environment of the laboratories would remain virtually the same irrespective of climatic zone. The use of artificial light and air-conditioning cannot be avoided. In the tropics, special care must be taken in the design of laboratories such that the effect of solar radiation is minimal on the laboratory rooms. Automatic stand-by plants are imperative.

This shcme is a hypothetical attempt to make a double contribution, firstly, to the architecture of Research Buildings and Environment, secondly, to the promotion and development of Science and Technology through Research in Nigeria. If it has had any meaning or better still, if it could spur anyone to act positively for the advancement of mankind and Nigeria in particular then no greater goal could be achieved by it. The scheme would be encouraged

A P P E N D I C E S

APPENDIX I - Some Relevant Tables

. Table 1 : Government Agricultural Research

. Table 2 : Private Agricultural Research

. Table 3 : Government Research Establishments of Industrial Nature, 1971

. Table 4 : Government Medical Research Establishments, 1971

. Table 5 : Science and Technology in Manufacturing Industries, 1971.

. Table 6 : Total Scientific and Technical Manpower Engaged in Research and Development Activities 1970 - 1971

. Table 7 : University Student Enrolment in the Sciences, 1970-71

. Table 8 : University Staff in Science and Technology (academic and Technical) 1970 - 71.

APPENDIX II - Site Plan of the CORE FACILITIES of the Proposed Research Centre

APPENDIX III - Main Entrance Elevation of the Proposed Research Centre

TABLE 1

GOVERNMENT AGRICULTURAL RESEARCH ESTABLISHMENTS, 1971

Establishment	Location	Nature of Research	Recurrent Exp. (Actual) 69/70 N£	Recurrent Exp. (Actual) 70/71 N£	No. of Scientists	No. of Technicians
1. Federal Department of Agricultural Research	Moor Plantation with units at Badeggi, Mokwa, Uyo, Umudike, etc.	Root crops, cereal crops, grain legumes horticultural and pasture crops and soil fertility.	308,489	341,716	50	58
2. Federal Department of Forestry Research	Ibadan, Zaria	Silviculture, ecology forest soils, tree physiology, mycology and forest products utilisation	119,901	125,967	24	19
3. Federal Department of Fisheries Research	Lagos, Lake-Chad, New Bussa and Buguma	Marine, Fresh water and brackish water fisheries research	62,571	72,178	11	7
4. Federal Department of Veterinary Research	Vom	Veterinary research and education including vaccine production and laboratory diagnosis of diseases	209,350	222,809	21	21
5. Cocoa Research Institute of Nigeria	Ibadan with sub-stations at Ikom, Ochanja and Mambilla	Improvement in production of cocoa and to some extent kola, coffee and cashew	381,778	365,665	31	99

TABLE 1 - Continued

GOVERNMENT AGRICULTURAL RESEARCH ESTABLISHMENTS, 1971

Establishment	Location	Nature of Research	Recurrent Exp. (Actual)		No.of Scientists	No.of Technicians
			69/70 N£	70/71 N£		
6. Nigerian Institute for Oil Palm Research	Benin with sub-Station	Improvement of production and processing of palm oil, and to a lesser extent other palms such as coconut, raffia and date	404,445	509,644	19	56
7. Nigerian Institute for Trypanosomiasis Research	Kaduna and Vom	Research on human and animal trypanosomiasis, and on tsetse-fly	124,758	275,754	10	25
8. Kainji Lake Research Project	New Bussa	Comprehensive development of man-made lake resources through research and surveys	46,165	48,515	13	5
9. Rubber Research	Iyanomo	Improvement of production and processing of rubber	48,426	69,710	6	5
		Total	1,705,883	2,031,958	185	331

TABLE 2

PRIVATE AGRICULTURAL RESEARCH ESTABLISHMENTS - 1971

Establishment	Location	Nature of Research	Actual Current Expenditure 1970	1971	No.of Scientists	No.of Technicians
1.International Institute of Tropical Agriculture	Ibadan	Research in production of tropical food crops such as maize, rice, grain legume, root and tuber crops.	447,545	717,617	29	26
2.African Timber and Plywood(Nig.)Ltd.	Sapele	Preservation of timber against insects and fungal depredation	*	*	*	*
		TOTAL : : £	447,354	717,617	29	26

* Note available

TABLE 3

GOVERNMENT RESEARCH ESTABLISHMENTS OF INDUSTRIAL NATURE, 1971

Establishment	Location	Nature of Research	Recurrent Exp. (Actual)		No. of Scientists	No. of Technical
1. Federal Institute of Industrial Research (Federal Ministry of Industries	Oshodi, Near Lagos.	Research on the processing of local raw materials for industrial use.	78,327	92,181	18	5
2. Nigeria Stored Products Research Institutes Federal Ministry of Trade	Lagos with branch at Kano, Ibadan, Port-Harcourt and Benin	Research into storage of agricutural products especially export crops	33,219	69,436	8	9
3. Materials and Research Division, Federal Ministry of Works and Housing	Lagos	Construction materials testing and research including soil Mechanics	37,307	37,715	5	11
4. Projects Development Agency (Cabinet Office), Enugu	Enugu	Applied Research and development· fabrication of equipments	*	71,000	13	
		TOTAL	148,853	270,332	44	37

* Non-existent.

TABLE 4

GOVERNMENT MEDICAL RESEARCH ESTABLISHMENTS, 1 971

Establishment	Location	Nature of Rsearch	Recurrent Exp. (Actual) 69/70 NF	70/71 N	No. of Scientists	No. of Technical
1. West African Council for Medical Research (Nigeria)	Yaba	Research into prevalent and peculiar diseases in Nigeria	80,000	80,000	1	-
2. Chemistry Division, Federal Ministry of Health	Lagos and Kaduna	Analytical Chemistry of foods, drugs, and water, Forensic Chemistry research	43,500	76,500	16	13
3. Malaria and Vector Control Unit	Yaba	Malaria and allied parasitic research	23,000	25,000	4	2
		TOTAL	146,500	181,500	21	15

TABLE 5

SCIENCE AND TECHNOLOGY IN MANUFACTURING INDUSTRIES - 1971

State	Lagos	Western	Mid-western	East-Central	Rivers	S.East	Kwara	Kano	North West	North East	North-Central	Jonus Plateau	Total
Number of Industries listed	482	131	106	225	82	71	28	95	16	20	49	132	1,442
Number Surveyed	63	39	20	48	12	23	23	31	12	6	13	39	330
Percentage Surveyed	13.1	29.8	18.8	20.66	14.6	32.4	82.1	33.7	75.0	30.0	28.3	29.6	22.9
Scientists and Technologists	218	37	24	97	115	232	68	57	40	7	62	76	1,033
Technicians	331	118	119	446	116	335	210	399	83	12	325	131	3,375
Other supporting Personnel, o.g. Operatives and Craftsmen	5,404	1,068	1,555	1,092	1,143	1,014	724	2,461	354	1951	8,491	1,178	22,769
Manpower and Expenditure on R. and D.	*	*	*	*	*	*	*	*	*	*	*	*	*

* Not available.

TABLE 6

TOTAL SCIENTIFIC AND TECHNICAL MANPOWER ENGAGED IN RESEARCH AND DEVELOPMENT ACTIVITIES 1970-71

Science Field	Government Research Establishments		Universities		Private Industry		Total	
	Scientists	Technicians	Scientists	Technicians	Scientists	Technicians	Scientists	Technicians
Agricuture including Forestry and Veterinary Science	185	331	191	30	29	26	405	387
Natural Sciences	-	-	392	53	-	-	392	53
Industrial Sciences including Enginnering and Technolgy	44	34	162	21	-	-	206	55
Medical Sciences	21	17	382	78	-	-	403	95
TOTAL	250	382	1,127	182	29	26	1,406	590

TABLE 7

UNIVERSITY STUDENT ENROLMENT IN THE SCIENCES 1970-71

University	Engineering, Technology and Architecture		Natural Sciences		Medicine		Pharmacy		Agriculture Forestry Veterinary Science		Total Science and Technology	Total Humanities Social Sciences Law Education etc.
	UG	PG	UG	PG	UG	PG	UG	PG	UG	PG	UG + PG	
Ibadan	-	-	798	74	622	40	-	-	331	48	1,913	1,872
Ife	164*	-	399	4	-	-	312	-	203	18	1,100	1,842
Lagos	208	6	308	13	370	4	-	-	-	-	909	1,411
Nigeria (Nsukka)	378	-	574	-	120	-	-	-	355	-	1,427	1,507
Ahmadu Bello	474	-	344	-	168	-	-	-	173	-	1,159	776
Benin	-	-	110	-	-	-	-	-	-	-	110	-
TOTAL	1,224	6	2,533	91	1,280	44	312	-	1,062	66	6,618(207)	7,408

* Technology only.
UG - Undergraduate Students
PG - Post-graduate Students.

TABLE 8

UNIVERSITY STAFF IN SCIENCE AND TECHNOLOGY (ACADEMIC AND TECHNICAL) 1970-71

University	Engineering, Architecture and Technology		Natural Science		Medicine Including Pharmacy		Agricul- Forestry Veterinary Science		Total Academic	Total Technicians
	Academic	Technicians	Academic	Technicians	Academic	Technician	Academic	Technicians		
Ibadan	-	-	82	15	128	30	58	10	268	55
Ife	19*	-	84	8	24**	2	46	4	173	14
Lagos	49	1	52	4	128	35	-	-	229	40
Nigeria(Nsukka	31	8	80	14	23	2	30	5	164	29
Ahmadu Bello	63	12	61	9	79	9	57	11	260	41
Benin	-	-	33	3	-	-	-	-	33	
	162	21	392	53	382	78	191	30	1,127	182

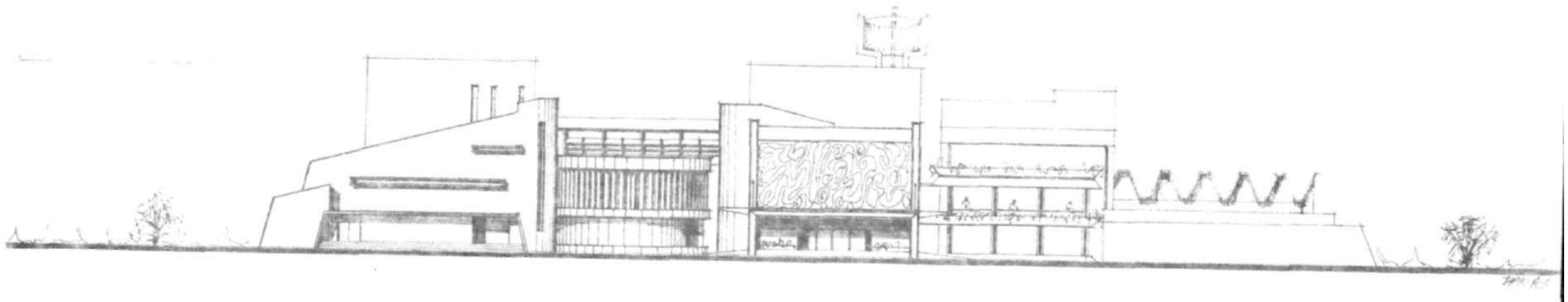
* Technology only

** Pharmacy only.



APPENDIX II part of the site plan, showing the CORE FACILITIES of the 'National Centre for Scientific Research & Dev. proposed in the Thesis.

DAN. AG.



APPENDIX III

main entrance elevation of the " National Centre for Scientific Research & Dev. "
proposed in the Thesis

scale 1 500

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

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