

A Botanical Biotechnology Institute for Mauritius

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A dissertation submitted to the School of Architecture, Planning and Housing - University of Kwa Zulu-Natal, Durban; in partial fulfillment towards the degree of Master of Architecture.

This dissertation is entirely my own, except where otherwise acknowledged.

Declaration

I hereby declare that this dissertation is my own unaided work except where otherwise acknowledged. It is being submitted to the school of architecture, Housing and Planning, University of Kwa-Zulu Natal, Howard College Campus, in partial fulfillment of the requirements towards the degree of Masters of Architecture. This dissertation has not been submitted before for any examination or degree at any University.

Signed 26th of August 2009

Table of Contents

Abbreviations	i
Acknowledgements	ii
Abstract	iii
Introduction	iv
Chapter 1- Research Background	1
1.1 The Geography of Mauritius.....	1
1.2 Definition of Agriculture.....	1
1.3 Economy of Mauritius.....	2
1.4 Agricultural Background.....	3
1.5 Biotechnology.....	3
1.6 Achievement in Biotechnology.....	4
1.7 Importance of the Agricultural Sector in Mauritius.....	5
1.8 Aiming for a future.....	8
1.9 Background to the proposed facility.....	10
1.9.1 Key Questions.....	10
1.10 Conclusions.....	10

Chapter 2- Research Methodology	11
2.1 Introduction.....	11
2.2 Primary Data.....	11
2.3Secondary Data.....	12
2.3.1 Literature Review and Theoretical Framework.....	12
2.3.2 Precedent Studies.....	12
2.4 Data Synthesis.....	13
2.5 Conclusion.....	13
Chapter 3- Literature Review and Theoretical Framework	14
3.1 Introduction.....	14
3.2 Literature Review.....	14
3.2.1 Comparison of laboratories and Office Block layout.....	15
3.2.2 Energy Efficient Laboratory Building.....	17
3.2.3 Form and Function.....	19
3.3 Theoretical Framework.....	20
3.3.1 Connecting people and Connection to Nature.....	20
3.3.2 The Concourse.....	21
3.3.3 The Creation of an Experience through a Building.....	22
3.3.4 A Social Structure.....	23
3.3.5 Order as an Architectural Approach.....	24

3.4 Conclusions.....	24
Chapter 4- Precedent Studies.....	25
4.1 Introduction.....	25
4.2 Institute of Forestry and Nature Research (IBN-DLO) in Wageningen- Netherland.....	27
4.3 The Donald Danforth Plant Science Centre, St Louis-USA.....	35
4.4 The Neuroscience Institute (NSI) in California- USA.....	44
4.5 Overall Conclusions drawn from Precedent Studies.....	50
4.6.1 Site Selection.....	50
4.6.2 Planning.....	50
4.6.3 Servicing.....	51
4.6.4 The Ecological Approach.....	51
4.6.5 The Humane Environment.....	51
4.6.6 Concluding Remarks.....	62
Chapter 5- Case Studies.....	53
5.1 Introduction.....	53
5.2 Food Technology Laboratory in Reduit, Mauritius.....	54
5.3 Sugar Milling Research Institute in Durban, South Africa.....	59
5.4 Overall Conclusions drawn from case studies.....	64
5.4.1 Servicing.....	64

5.4.2 Flexibility.....	64
5.4.3 Planning.....	64
5.4.4 The Humane Environment.....	65
5.4.5 Imagery.....	65
5.4.6 Concluding Remarks.....	65
Chapter 6- Formulation of the Design Brief.....	66
6.1 Introduction.....	66
6.2 Brief Formulation.....	66
6.2.1 Client and Funding.....	66
6.2.2 Site Requirements.....	66
6.2.3 Users.....	67
6.2.4 Client's Objectives.....	67
6.2.5 Design Objectives.....	67
6.3 The Derived Brief.....	68
Chapter 7- Technical and Environmental Criteria in Laboratory Buildings.....	69
7.1 Introduction.....	69
7.2 General Planning.....	69
7.3 Structure.....	75
7.4 Servicing.....	76

7.5 Safety.....85

7.6 A Social Building.....86

7.7 Illumination.....87

7.8 Finishes.....88

7.9 Storage.....88

7.10 Incubators.....89

7.11 Greenhouses.....89

7.12 Other General Criteria.....90

7.13 Conclusions.....90

Chapter 8- Conclusions and recommendations.....91

8.1 Introduction.....91

8.2 The Design Approach.....91

8.3 Concluding remarks.....93

Bibliography.....94

Appendix A - Outline of Structured Interviews.....A

Appendix B- Area Analysis.....B

Appendix C- Design Report.....C

Abbreviations

CGIAR: Consultative Group on International Agricultural Research

COMESA: Common Market for Eastern and Southern Africa

CSIR: Council for Scientific and Industrial Research

DNA: Deoxyribonucleic Acids

EU: European Union

GAP: Good Agricultural Practices

GMO: Genetically Modified Organism

IOC: Indian Ocean Commission

ISO: International Organisation for Standardisation

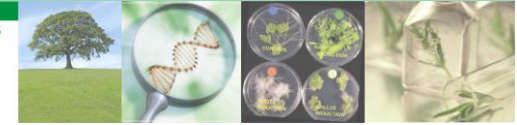
MAFTNR: Ministry of Agriculture, Food Technology and Natural Resources

M.O.A: Ministry of Agriculture

MUR: Mauritian Rupees

SADC: South African Development Community

SMRI: Sugar Milling Research Institute



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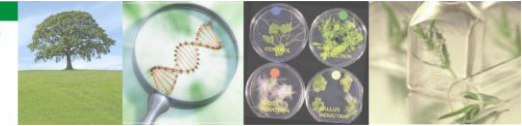
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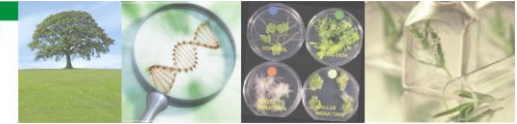
Abstract

This research document focuses on architectural identity and the design of research institutes. Architectural identity deals with conceptual ideals while relating the context: political, economic, social and climatic. The research facility to be dealt with in this document is a Biotechnology Institute for Mauritius. Biotechnology is the application of genetically modifying the DNA characteristics of a living organism through advanced scientific approaches. It is a new technology used for food safety. Globally, questions have been asked about its usage and application. Food crisis is becoming a world-wide issue, socially and economically.

Literature searches carried out made clear that laboratory design is a complex building type that needs to have flexible services, planning and more important, the need for informal interactions between scientists. The actual laboratory spaces need special requirements for safety and regulations are set by international standards. While these sets of requirements have to be observed, the architectural identity will be derived from concepts that will be looked at in the literature review but also the context in which the proposed facility will be located.

After analysing these criteria, a recommendation or guideline is set for the design of a new Botanical Biotechnology Institute in Mauritius.

Agriculture has evolved with time from examining wild plants that were edible in the prehistoric ages, the traditional cultivation of plants and rearing of animals to the scientific agricultural application such as transplantation to the modern technology application which is biotechnology. Agriculture is an important key element in the socio-economic development of a country. Mauritius, which was one of the biggest exporters of sugarcane, anthurium and other fruits and flowers, is now finding it difficult to compete with other countries as a result of poor technological input and capital investment. The new proposed Botanical Biotechnology Institute could enable Mauritius to emerge as a 'Centre of Excellence' and encourage transfer of know-how and technology to the region.

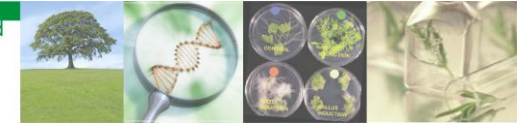


Introduction

Globally, questions have been asked about the usage and application of Biotechnology. The Food Crisis is becoming an issue, socially and economically. Socially, people are starving in Third World countries due to the lack of resources and management. There is not enough food to feed the whole world. Economically, countries that used to generate money through exporting agricultural products are finding it difficult to reach their exporting quotas due to plant diseases, climatic interference and because of price competition with others. Attempts have been made to seek solutions, but still, the world is not producing enough food. The use of biotechnology is currently applied in developing countries to be able to reach the food demand.

The government of Mauritius came up with a proposal to set up a biotechnology institute as a result of a drastic drop in its food exports, which affected the economy. The proposed facility is a Botanical Biotechnology Institute that would examine and carry out research on plants, vegetables and flowers. Such an institute will examine and research possibilities that will help local planters and the country.

The need to analyse precedent and case studies is critical in the design process of a new Botanical Biotechnology Institute, where a critical assessment of selected buildings has been undertaken. These have been formulated for the design requirements of the new facility and research has been carried out on the technical aspects of laboratory design, culminating in a brief for the design of a new Botanical Biotechnology Institute.



Chapter 1- Research Background

1.1 The Geography of Mauritius

The Republic of Mauritius comprises the islands of Mauritius, Rodrigues, Agalega, St Brandon and a number of outlying smaller islands, all located in the South of the Indian Ocean. Mauritius, the principal island with latitude 20°S and longitude 58°E lies some 900km east of Madagascar and has a land area of 1865km². Geologically, the island is the oldest of the Mascarene group which also includes Reunion Island (a French territory) and Rodrigues. The islands are all volcanic in origin, having emerged from the ocean floor. Mauritius has a tropical maritime climate generally dominated by the South East trade winds and enjoys warm moist summer during the months of December to May and a cold dry winter from June to November (Saddul 1995: 5). The island is a multi ethnic society which is comprised of Indo-Mauritian (68%), Creole (27%), Sino-Mauritian (3%) and Franco-Mauritian (2%). The official language is English but the most commonly spoken languages are French and Creole. The urban- rural distinction is that 41% of the population lives in cities and the remaining 59% in rural areas. (Fahamu 2002: 76)

1.2 Definition of Agriculture

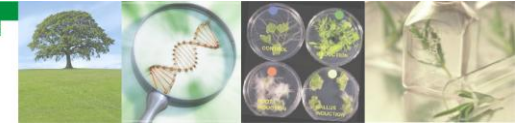
Agriculture (from Lat. *ager*, field, and *colere*, to cultivate) is the science, art, and industry of utilising the soil so as to produce the means of human subsistence, embracing in its broad sense the rearing of livestock as well as the raising of crops. The history of agriculture is the history of man in his/her most primitive and most permanent aspect. The simplest form of agriculture is that in which crops are raised from one patch of ground till it is exhausted, when it is allowed to go wild and abandoned for another.



Illustration 1.1.1: Mauritius in relationship with other islands and continents (Hayes and Jarvis: n.p)



Illustration 1.1.2: Sugarcane fields in the Moka District, Mauritius (Kureemun 2008: n.p)



Since agriculture began to be developed, peoples everywhere have discovered the food value of wild plants and animals and domesticated and bred them. (BioWorld: n.p)

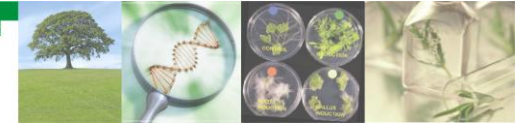
1.3 Economy of Mauritius

Agriculture has historically been the spine of the Mauritian economy, characterised for a long time by sugarcane monoculture. While in the 1970s, agricultural exports represented around 97% of all exports, this figure has witnessed a gradual decline to reach 17% in the year 2000 (MAFTNR 2003: 1). Policies for the diversification of the Mauritian economy were undertaken since the early 1970s based, in the first instance, on the textile industry, and later on tourism and services sectors, all three of which proved to be promising. Due to this diversification, the economy, has, in the process, moved away from its quasi-exclusive dependence on sugar to a more broad-based and diversified one (MAFTNR 2003: 1). Currently, the agricultural sector is no longer the main income of the country. (Saddul 1995:2). Tourism had to take over due to the cost of production in the agricultural sector.



Illustration 1.1.3: The beaches of Mauritius are of the main attraction for tourism (BBC 2002: n.p)

Mauritius experienced strong economic growth during the 1980s and witnessed an increase in its Gross Domestic Product (GDP) rising from MUR 7300 million in that year to MUR 117,795 million in 2001. The main contributor to GDP in 2001 has been the services sector accounting for about 70% of GDP with the manufacturing and agricultural sectors accounting for about 24% and 6% respectively of GDP. Growth in the agricultural sector has not kept pace with that of the other sectors of the economy (MAFTNR 2003: 1).



1.4 Agricultural Background

As a result of a population explosion in the era following World War II, there was a thrust towards more food production. A so-called green revolution, involving selective breeding of traditional crops for high yields, new hybrids, and intensive cultivation methods adapted to the climates and cultural conditions of densely populated countries temporarily stemmed the pressure for more food. New issues such as famine, drought, shortage of petroleum, and natural disasters became the determinants of agricultural change and development. (Bioworld Products Ltd: n.p)

1.5 Biotechnology

As the 21st century approached, developing countries are struggling with side effects of the Green Revolution. The excessive use of agricultural chemicals has polluted the land, wildlife, and water. In addition, the world's population is growing beyond the Green Revolution's capacity to feed. There will not be enough land to feed the 9 billion people predicted by 2050. Scientists argue that a new "Gene Revolution" can help both, the humanity and the sensitive environment. The Gene Revolution forms part of biotechnology to create new genetically modified (GM) crops. Potentially, these crops can produce more food with fewer chemicals and higher nutritional value than traditional crops. Scientists believe that more crops could be improved than the Green Revolution did with grains, vegetables and fruits that people need for a balanced nutritional diet. (Cathryne 2000:2,3)

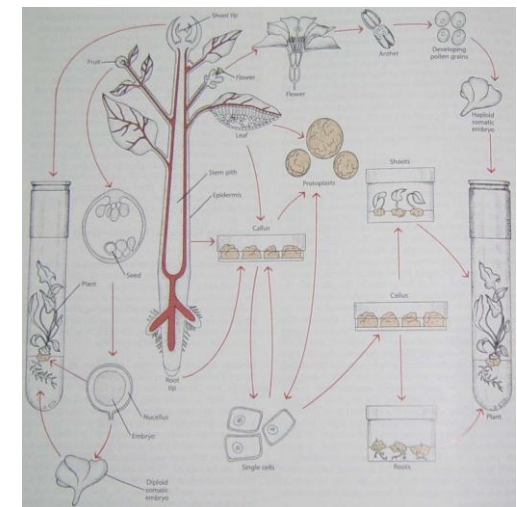
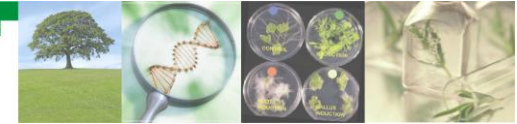


Illustration 1.1.4: Biotechnology process on a plant sample (Raven 1999: 694)

Biotechnology is a result of combining biological science with technology. This new form of technology has been made possible due to the revolutionary discoveries made in the two areas mentioned. "Biotechnology is not a pure science, but an integrated effort of these two, the root of which lies in



biological science,” (Dubey 1999: 3). Biotechnology has been broadly defined as “the development and utilisation of biological processes, forms and systems for obtaining maximum benefits to man and other forms of life”. (Dubey 1999:3)

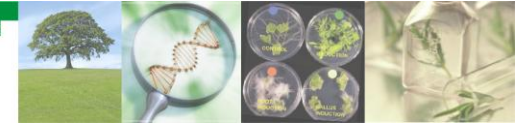
“Biotechnology in agriculture is now recognised by the international scientific community to be an essential and increasingly important element of a critical strategy, integrating both conventional and biotechnological applications, in order to achieve future food security” (MAFTNR 2003: 165). There are various factors affecting the traditional way of boosting the agricultural sector. This encourages the use of this new technology.

1.6 Achievement in Biotechnology

The importance of biotechnology in agriculture to solve fundamental problems in food production is highly successful compared to the conventional techniques that have been very limited. (Puchooa: 2)

Biotechnology companies around the world, including the Consultative Group on International Agricultural Research (CGIAR), and numerous academics have continuously argued the need to increase agricultural productivity so that sufficient food supplies exist to meet the demand forthcoming from an increase of world population. In the absence of considerable productivity gains, there will not be sufficient food quantities to feed the projected population of about 9 billion. (Ruttan 1999: n.p)

In the last decade, more than 8 million farmers in 21 countries (as example China, Argentina and Brazil) have grown genetically modified crops. This results in an increased income for large and small



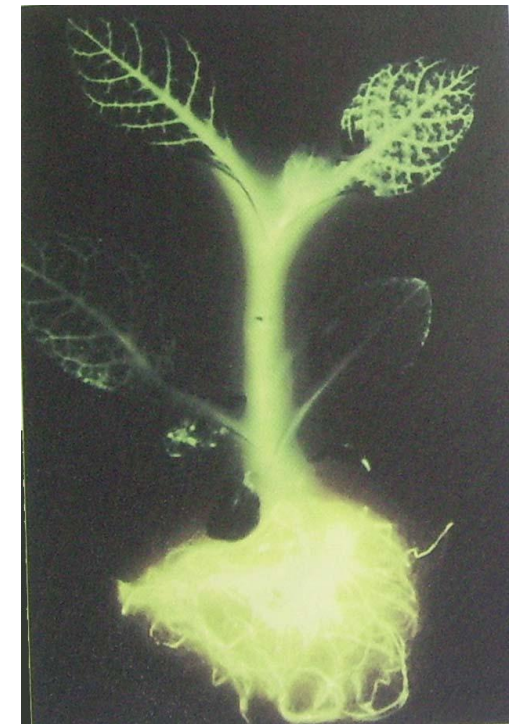
farmers and decreasing the impact of agriculture on the environment. Biotech crops have been used in such countries as the primary reason is the economic benefits that farmers get from the technology. Benefits have also been noticed in the environmental aspects such that there has been a reduction in pesticide usage of 6%, a reduction in the release of greenhouse gas emissions or carbon dioxide by 10 million metric tons. This is equivalent to the amount of carbon dioxide released by 10% of cars on the road in the United Kingdom. So in other words, it is equivalent of taking 20% of the UK cars off the road for a year. (Brooks 2005: n.p)

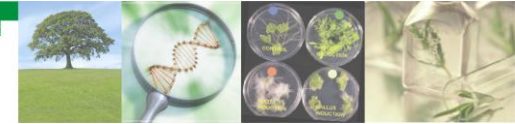
Transgenic crops are being adopted at the global level but only a few developing countries are growing them in significant quantities. These crops are successful in such countries as institutional factors such as national agricultural research capacity, environmental and food safety regulations and agricultural input markets matter as much as technology itself in determining the level and distribution of economic benefits. (Brooks 2005: n.p)

Biotechnology has also caused a revolution in the field of agricultural science. Inter-genetic crosses are now possible and this allow hybrid of plants to grow. Such specimen can grow in various conditions depending on how their DNAs have been modified. It has also helped in disease resistant plants (Dubey 1999:3).

1.7 Importance of the Agricultural Sector in Mauritius

The sugar production is still playing an important role in the socio- economic set up of the country, yet its contribution to the economy has been declining over the years. This reflects the growing



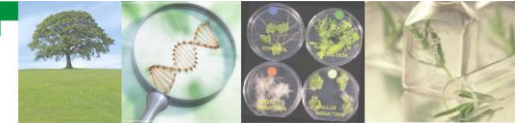


diversification of the Mauritian economy with the secondary and tertiary sectors registering relatively higher growth rates over the last five years. This trend underscores the fact that both in terms of technology input and capital investment, agriculture has been lagging behind (MAFTNR 2003: 2).

The contribution of agriculture in the economy has decreased. Sugarcane production accounts for around 53% of this share. Food crops account for around 17% and livestock for 12%, while flowers, fruits and forestry account for the remaining 4% of the share of agriculture to GDP. The share of tea and tobacco to GDP are presently negligible. In terms of exports, sugar is the principal commodity to the tune of 86% of all agricultural exports. The country also exports some flowers and foliage but this accounts for approximately 2% of total agricultural exports. Although the local production of foodcrops caters to a large extent for the needs of the population, its contribution to exports has remained negligible. (MAFTNR 2003: 2)

Direct employment in the agricultural sector stood at 29% of total employment in 1980 but fell to 10% in 2000 (around 50,000 persons) with more than half the number employed in sugarcane production. Additionally, there are 34,000 small planters who are mostly involved in sugarcane production. The small planters have different levels of commitment to agriculture and their plot size in 90% of cases does not exceed 2 hectares. (MAFTNR 2003: 2)

The approach to agriculture in Mauritius has generally remained traditional. Most of the fertile land remained under sugarcane cultivation. There has been no adequate planning to ensure optimal utilisation of the land resources. Between 1960 and 1980, development of export for the tea and anthurium industries was attempted. The former eventually became an unprofitable activity because of



quality constraints and uncompetitive prices on the world market. However, anthurium exports, although initiated rather timidly, gained momentum to become an economically viable activity in the early 1980's. With new prospects offered by this industry, the number of new entrants increased considerably such that by the late 1980's this sub-sector became the second largest money-generating industry in the agricultural exports sector, after sugar. (MAFTNR 2003: 3)

Exports of pineapple and litchi have mainly targeted niche markets in the European Union. These items are exported fresh, which constitutes a freight disadvantage. These commodities offer a number of possibilities on the export front which, however, to date remain untapped.

Fruit production has been limited to only a few items, mainly banana, litchis, pineapple and mango. Imports of fruits have risen considerably over the years, the main reasons being (MAFTNR 2003: 3):

- (i) a rising demand stemming from higher standard of living of the population;
- (ii) an increasing health awareness; and mainly,
- (iii) the availability of better quality and variety fruits and at cheaper rates than locally produced ones.

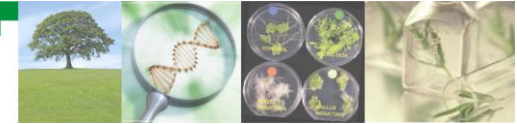
Trade liberalisation within the Southern African Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA) countries will increasingly open markets and encourage new entrants. Other producer countries, having the advantages of product diversity and price competitiveness over Mauritius, can in no time flood the local market with agricultural and agro-based products, to the detriment of local producers. The majority of these agriculturally oriented countries have comparatively larger land expanses and cheaper cost of labour than Mauritius (MAFTNR 2003: 8).



*Illustration 1.1.6: Anthurium plants
(Forbes 2003: n.p)*



*Illustration 1.1.7: Fruits of Mauritius
(COMESA Trade Hub: n.p)*



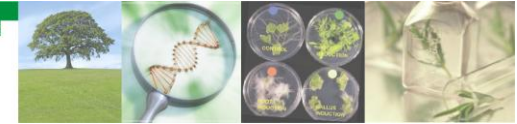
There is no doubt therefore that Mauritius is confronted with fierce competition on the agricultural front. There is, first and foremost, significant pressure on land utilisation in favour of alternative high-value economic activities. The country is also highly dependent on imports for key raw materials especially fossil-based ones. In view of its geographical positioning, imports of inputs tend to be constraining, and exports increasingly uncompetitive, due to high cost of freight. Being a large importer of food and other items, Mauritius is often considerably affected by changes in world commodity prices and by currency fluctuations. (MAFTNR 2003: 8)

With opportunities provided under the Africa Growth and Opportunity Act (AGOA), which aims at fostering trade links between the USA and Africa, the United States may represent a promising market avenue in the future. Along the line of the plan, with emphasis laid on enhanced production volume and quality, there is a need to simultaneously trigger the right mechanism to promote non-sugar agricultural exports more aggressively. Niche export markets may be found within the framework of the AGOA. The country also requires up-to-date market intelligence along with the need to establish export quality norms and standards rigorously. But even a very small share of the US market represents a huge opportunity for Mauritius. (Puchooa 2004: 12)

1.8 Aiming for a future

Mauritius is moving towards a knowledge and service based economy. The long-term survival and future of its agriculture should therefore be envisaged along the same policy orientation.

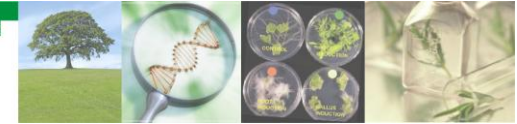
Research is also another essential component for the sustainability and profitability of any economic activity as regards agriculture, which will be given due consideration in this plan. The aim would be to



impart the appropriate research back-up to our established economic industries in the sector, for instance (sugar, anthurium, pineapple, etc) to enable the country to exploit the full commercial potential of these commodities while allowing it to keep pace with the changing market tendencies. In this respect, the proposed establishment of the National Food and Agricultural Biotechnology Institute with a dynamic and well-equipped research arm will surely be a spearheading initiative. Research and its subsequent application will represent the golden rule for success in the agricultural sector. Research in horticulture for varietal adaptability and suitability for the industry and its subsequent application in conjunction with the appropriate technologies hold the key to the successful sophisticated agriculture being targeted (Puchooa 2004: 8).

Eventually, as a high-tech agricultural state, it will be essential to encourage transfer of know-how and technology to the region, making optimal use of the technical and manpower resources. This will enable Mauritius to emerge as a 'Centre of Excellence' and as a resource bank in terms of capable manpower resources for regional training processes. (MAFTNR 2003: 3)

The world wide food crisis is due to the poor food harvest which occurred during this year, 2008. Added to this, people are using cereal (mainly soya and maize) to produce bio-fuel because of the petroleum prices that has increased significantly. All these have contributed to the food crisis (Source: Soobrattee M.H- personal communication).



1.9 Background to the proposed Facility

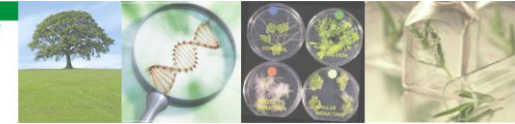
The proposed institute will therefore consist of laboratories, offices, a library and seminar venues. Research on plants will be carried out using the biotechnology process. The facility will examine and research the possibilities for plants to survive in the ever changing climatic conditions and diseases that affect them. It will be open to visiting professionals collaborating with the staff and/or organisations attending occasional seminars and agricultural students from the University of Mauritius who need to consult staff members.

1.9.1 Key Questions

- How can the quality of research be improved by the built environment?
- What is the most suitable design approach to deal with the immediate and future requirements of the facility and its services?
- How can the design facilitate interactions among the users of the building?
- What are the sustainable approaches of the scheme?

1.10 Conclusions

This research document co-incides at a very critical time to address the economic issues the country is experiencing, and at an international level, the food crisis the world is experiencing, particularly the African region. The importance of this project is not only benefiting Mauritius but the entire SADC region.



Chapter 2- Research Methodology

2.1 Introduction

The method of information collection through primary and secondary data will inform the design process. Existing research facilities related to biotechnology and other building types will be looked at and relevant aspects of each will be examined to define a brief.

2.2 Primary Data

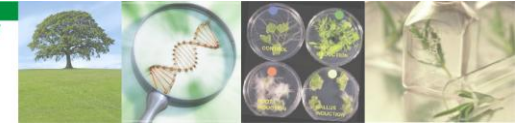
Primary data consists of interviews with key informants such as laboratory staff, heads of institutes/departments and architects. It also includes case studies where the author had to visit and understand the functionality and use of spaces. Two case studies were carried out.

The criteria used in the selection of case studies included:

- Existing research facilities related to the topic, that is biotechnology.
- Proximity to study area.
- The ability to compare and identify trends in design.

From those set criteria, the following case studies were selected:

- The Food Technology Laboratory in Mauritius
- The Sugar Milling Research Institute in Durban, South Africa



2.3 Secondary Data

2.3.1 Literature Review & Theoretical Framework

The literature review serves to give a broader analysis to the design of research facilities. It focuses on technical issues and concept dealing with research facilities.

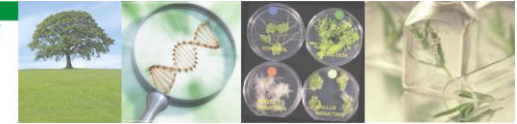
Such analysis would motivate the development of a new Botanical Biotechnology Institute in Mauritius.

The Theoretical Framework will focus on philosophies that would lead towards the design of the proposed facility. Such philosophy would be based upon existing theories and concepts identified within buildings.

2.3.2 Precedent Studies

The precedent studies analysed are:

- Institute of Forestry and Nature Research (IBN- DLO), Wageningen, Netherlands; 1994-1998; designed by Stefan Behnisch, of Behnisch, Behnisch & Partners
- Donald Danforth Plant Science Centre- Nicholas Grimshaw and Partners (NGP) in association with HOK Architects- 1998-2001
- Neurosciences Institute (NSI), California, United States- designed by Tod Williams Billie Tsien & Associates



Each precedent has been assessed under the following headings:

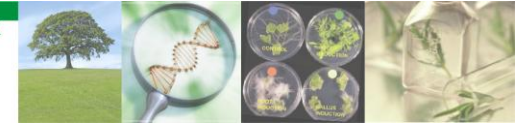
- An introduction to the project*
- *The Brief*
- Design Concepts*
- Site Characteristics*
- Spatial Arrangement of the accommodation*
- Positive aspects in the design*
- Negative aspects in the design*
- *A summary of lessons learnt and its contribution to the design of a new Plant Biotechnology Institute*

2.4 Data Synthesis

The findings and observations drawn from the primary and secondary data were used to produce and develop a brief through the understanding of all criteria mentioned above.

2.5 Conclusions

The literature review and theoretical framework will give a general understanding of issues regarding the design of research facilities and conceptual framework that will help the design of a new biotechnology laboratory. The case studies will demonstrate the practicality of some recommendations made in the conclusions drawn from the precedent studies. It will also help the designer to understand how an institute functions and practicality of spaces needed for the users in the building.



Chapter 3- Literature Review and Theoretical Framework

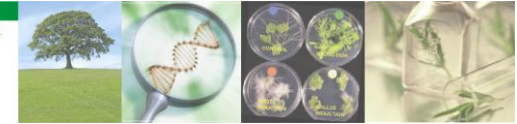
3.1 Introduction

This chapter will deal with existing publications focusing on research facilities and concepts that would inform the design of a new research institute. The aim of the literature review is to give an overview of how a research facility should function and other important considerations, whereas the theoretical framework will examine the intended goals and concepts underlying the design of laboratory facilities.

3.2 Literature Review

The construction of new research facilities requires close communication between the laboratory users, project engineers, architects, construction engineers, safety and health personnel. The main objective of laboratory design is to provide a safe working environment for scientists, engineers and staff members (Diberardinis et al 1993:1).

Laboratory designs is an integration of highly complex services and important factors such as efficiency, economy, energy conservation, and design flexibility are always in the lime light (Diberardinis 1993: 2). It is an introverted space which is artificially lit and ventilated due to the experiments being conducted.



Because construction costs and services of research facilities are high, architects try to reduce the servicing factor through a sustainability approach. In some cases, clients are relieved to see their servicing cost being reduced through ecological approaches.

3.2.1 Comparison of Laboratories and Office Block layout

The architectural treatment at the Biological Sciences and Biomedical Engineering at the University of New South Wales (*illustration 3.2.1*) in Sydney resulted from a careful and sensitive contextual analysis. The site determined the urban form of the building, a curving road producing a curving pointed plan at the east end of the building sheltering the laboratory spaces. The approach of the architects: Laurence Nield & Partners' to the laboratory spaces was by simple and logical planning with large glazed panels between the laboratories and corridors. These panels allow natural light to penetrate into the corridor but also expose the workers in the laboratories to the corridor. It also acts as a safety feature, where people dealing with hazardous chemicals can readily be seen from the corridor.

Louis Kahn's approach to the Salk Institute (*illustration 3.2.2*) includes flexible laboratory spaces and a range of highly specific spaces for retreat, writing, and thought, communal use and offices. These are arranged around the laboratory space with service spaces, plant rooms and administration (*illustration 3.2.3*). All these form a 'block' that functions on its own same as the traditional American office building type.

Comparing the Salk Institute with a traditional American Office building in terms of planning, the former consists of laboratory spaces being surrounded with offices and service spaces and similarly, the

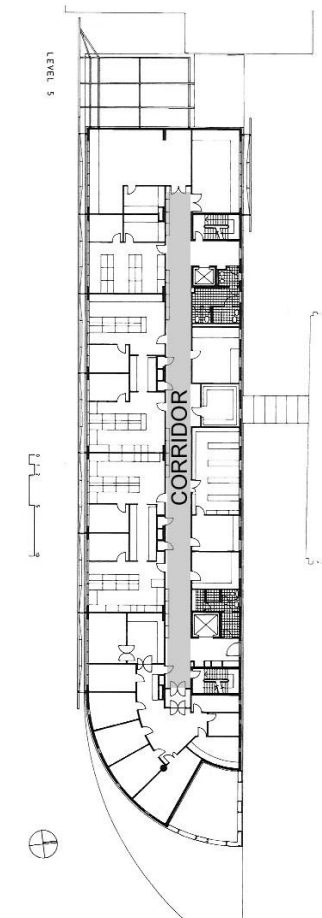
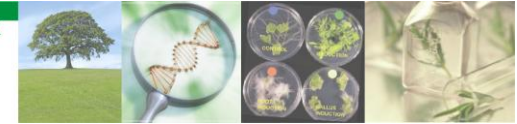


Illustration 3.2.1: Laboratory Floor Plan of the Biological Sciences & Biomedical Engineering (Griffin B. 2000:109)



typical American office building has cellularised offices at the perimeter, allowing natural light with the open plan and vertical core at the centre of scheme (*illustration 3.2.4*). The result of such approach ends up with a poor humane environment for the users, especially for those working in the open plan office with no natural light and ventilation; likewise it applies for the laboratory spaces at the Salk Institute.

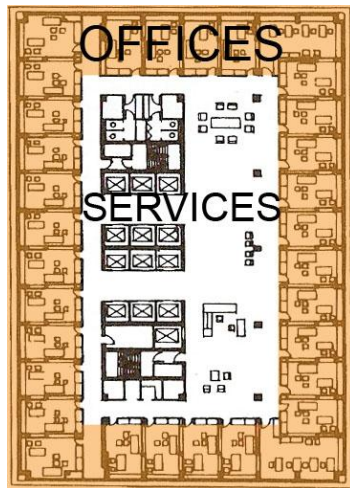


Illustration 3.2.4: The typical American office building with cellularised offices surrounding the services area incorporating the lift cores and open plan offices(Neufert. et al 2004: 355).

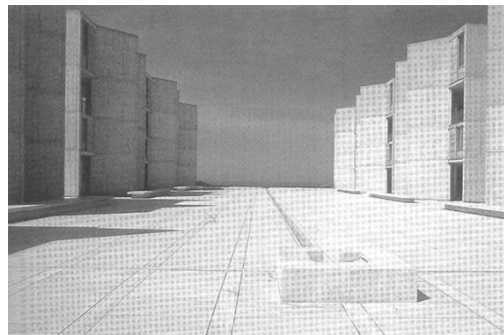


Illustration 3.2.3: The courtyard space between the two blocks, terminating with a view to the Pacific Ocean (Treib 2006: 403)

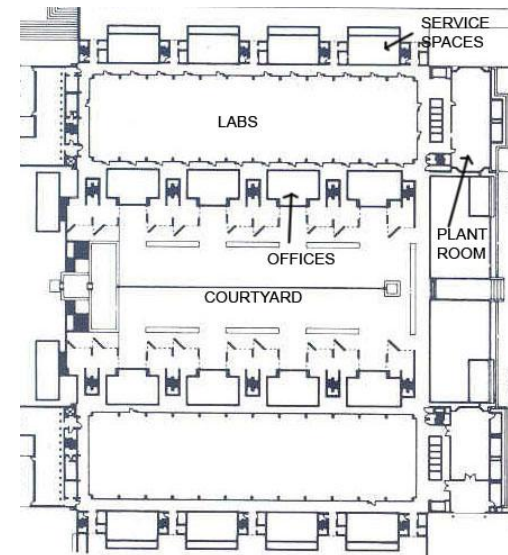
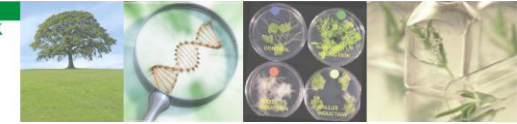


Illustration 3.2.2: Ground floor plan. The two wings of laboratories with support spaces border the plaza to the north and south. There is a very deliberate hierarchy of space emanating from the centre, the plaza (Cosbie 1993: 42).



3.2.2 Energy Efficient Laboratory Building

Compared to other spaces in a research facility, laboratories consume a high level of energy through air-conditioning, artificial lighting etc. All energy used contributes to the greenhouse gas emission, and thus, contributes to the global warming. The need to minimise the energy demand through efficient servicing and planning is the most suitable strategy. Architects David Murray Associates designed the Institute of Medical Science at the University of Aberdeen in Scotland. The design comprises a double height laboratory aligned along a corridor. The offices are on the other side of the corridor overlooking into the central covered atrium used as the social focus of the institute. Mezzanine office floors are located within the double height structure, taking over the left-over space by the laboratories. Such approach allows for maximum natural light penetrating through the laboratories and offices.

The atrium is the dividing and ruling element of the scheme. Researchers retreat from their labs to their offices to write up their experiments in both research blocks. The magnet that attracts them to the atrium is the coffee shop.

Furthermore, the fact that the proposed facility is in Mauritius, which is a tropical island, the design principles for a climatic responsive building should be considered. A careful planning can result in a building that consumes less energy while abiding to sustainable approaches.

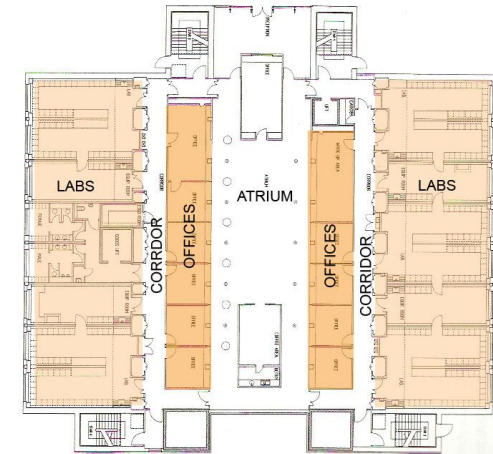


Illustration 3.2.5: Typical Floor Plan of Institute of Medical Science with 2 wings of labs each with offices overlooking an atrium (Griffin 2000: 158).

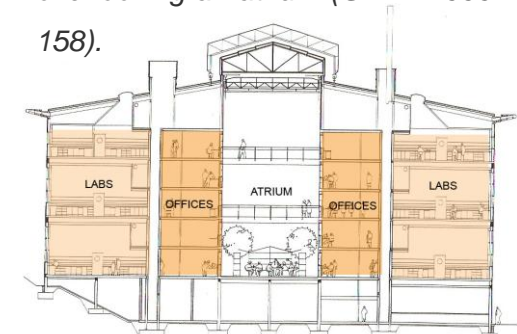
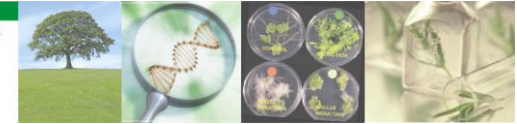


Illustration 3.2.6: Section showing double height laboratories corresponding to two office floors and service access corridors at the Medical Science building (Griffin 2000: 159)



The Rand Afrikaans University Laboratories designed by Wilhelm O. Meyer and Jan Van Wijk and Partners, consists also of an atrium with two parallel laboratory wings. In this case, as these are teaching laboratories, the offices are situated in the same laboratory spaces, thus using the same volume. The energy consumption could be reduced with some of its offices overlooking outside, using natural light and ventilation.

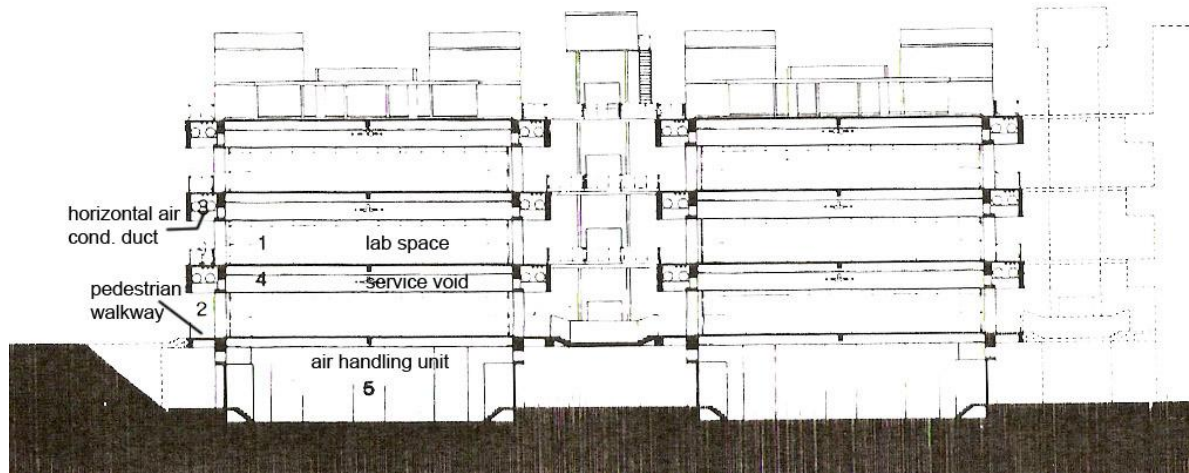


Illustration 3.2.8: Cross section through the R.A.U laboratory showing the volumetric spaces through the building (Hoffrichter 1973: 31)

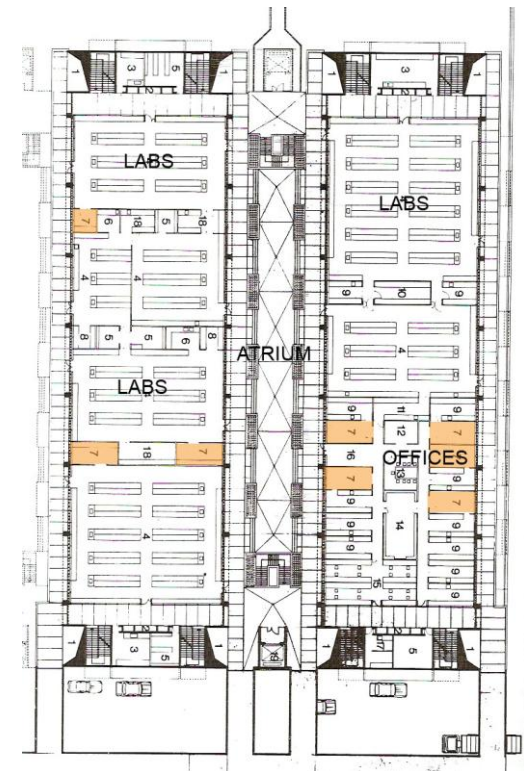
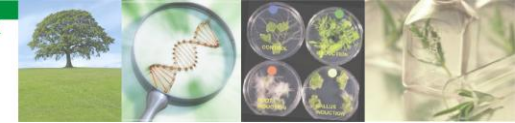


Illustration 3.2.7: Typical floor plan for Zoology and Botany lab at RAU with offices occupying the same volumetric spaces as labs (Hoffrichter 1973: 31)



3.2.3 Form and Function

Modernist architects had the idea that ‘form follows function’. It involves the notion that the origins of the form of a building are a logical consequence of its function (Righini 2000: 35). Such theory is applicable for laboratories where loss of spaces is reduced.

In a laboratory building, the services are closely related to the functions more than to the spaces. Therefore, structurally the building should be flexible and the best space with flexible services and a minimum of structural interference is usually achieved through the use of inter-floor service space. The column-free floors are spanned by deep trusses where the services run and these are accessible over the whole area of the building (Weeks 1986: 9)

Because laboratory spaces and their furniture/workbenches are based on modules, the end product of such spaces is usually a linear form. The more unused floor area within a laboratory increases energy consumption; as such spaces are usually artificially ventilated. Besides, the maintenance of laboratories and its servicing are costly; thus, wasted spaces should be avoided within such environment.

3.3 Theoretical Framework

3.3.1 Connecting people and Connection to Nature

According to Miles H, “*The principle is that folk should have a wide range of places in which to think and work, that the corporation will get the most out of its employees if they are given a congenial and*

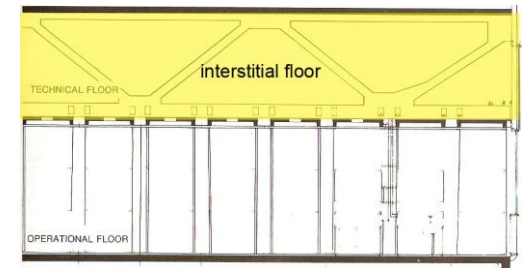
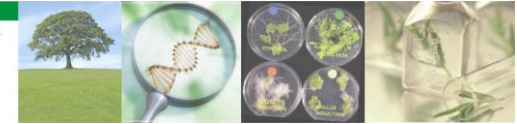


Illustration 3.2.9: The volumetric spaces above as an inter-floor service space (Weeks 1986: 9)



varied workplace, and that if you are employing a lot of very brainy people, there is a great deal to be gained in encouraging casual social contacts between them, from which quite unexpected and startling ideas may begin to emerge” (Miles 1995: 56). For instance, the restaurant at the Research Complex in Sweden acts a node and meeting space for informal discussions.



Illustration 3.3.1: The restaurant at the Research Complex capturing the view (Miles 1995: 56).

The connection to the natural environment is another aspect raised by Miles H: “Because clever and decent people generally want to be as near as possible to nature, the transparency of the perimeter has been maximized” (Miles 1995: 56) in the Research Complex.

In comparing the Research Complex to the Salk Institute, it is noted that the latter has a plaza/courtyard space that divides the facility into two distinctive parts with the aim to allow researchers to interact. Conceptually, such an approach is profitable for the users. However, practically, the plaza is an empty space. By separating the institute into two blocks with an enormous plaza, there is less human interaction between the two. Therefore, the planning of the new proposed institute and movement of its users should be taken into consideration to promote interactions among its users.



Illustration 3.3.2: The connection to nature with the corridor overlooking the landscape (Miles 1995: 56)

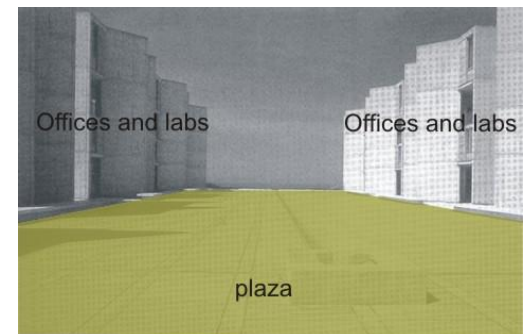
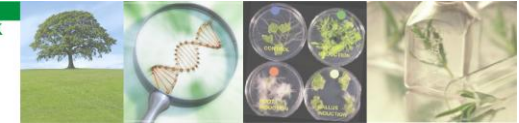


Illustration 3.3.3: Empty and poor landscaping at the Salk Institute within the plaza (Treib 2006: 403)



3.3.2 The Concourse

A concourse is a main public space through which people flow. It is used as the main spine in shopping malls and airports that filters people to other spaces. The contemporary approach to concourses is to have other elements annexed to it. As Alexander suggests, *“to recreate a social intercourse, the route taken between places need to be conceived of as a truly public space”* (Alexander 1977:490). His recommendations can be used to promote life on the street include:

- Individual wings having their own entrances that open onto the street
- Entrances from all upstairs offices should open directly onto the street
- The size of such concourse should have a width so that people can feel comfortable walking or stopping
- the acknowledgement of volumetric spaces
- the penetration of natural light
- the concourse should allow free loitering

However, it can also be used to separate the very public realm to the private part of a building, as illustrated in the ‘O’ Hare International Airport (*illustration 3.3.4*) and the Constitutional Court in Johannesburg (*illustration 3.3.6*). The

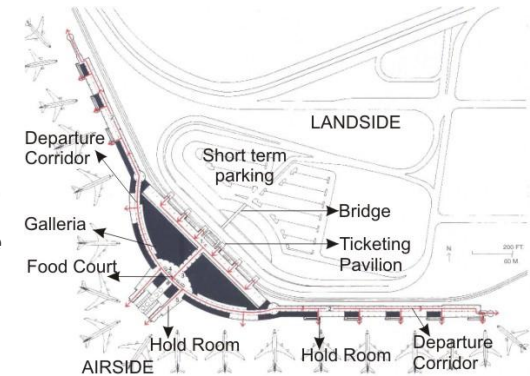


Illustration 3.3.4: The concourse at the O’ Hare International Airport with the ticketing pavilion as the most public space (Branch 1993: 95)

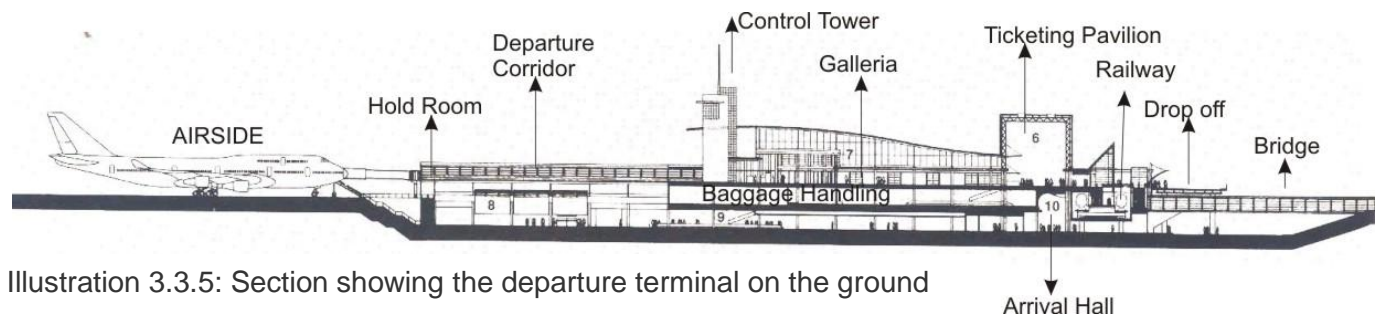
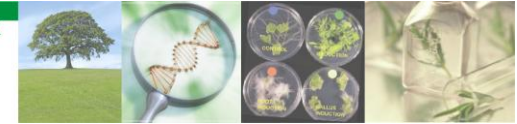


Illustration 3.3.5: Section showing the departure terminal on the ground floor and the arrival terminal on the lower ground floor (Branch 1993: 95)



former consists of a ticketing pavilion that acts as the main semi-public space before reaching the departure corridor. The section (*Illustration 3.3.5*) shows the importance of the concourse through the use of a bigger volumetric spaces and allowing natural light to penetrate through. It is the main space where all departing passengers will flow through before each move to their own departure corridor.

The Constitutional court Building in Johannesburg is a very linear scheme with a concourse used as a feature and functional part of the building. The concourse is layered as an exhibition space linked to the Judges' Chambers.

3.3.3 The creation of an experience through a building

The creation of a unique experience is the key ingredient which separates ordinary buildings from extraordinary architecture. Such experiences can be in terms of materials used, forms and connection to views or the natural environment.

Architect John Portman's approach to environmental design "*is based on observations of the way people behave in public spaces. He tries to anticipate the physiological reaction of the building's ultimate user and plans accordingly.*" (Portman et. al 1976: 5). People cannot walk in a Portman building and remain unconscious to their surrounding. They look up, amazed by the large and unusual spaces; they explore and are eager to try out the different experiences that the building offers.

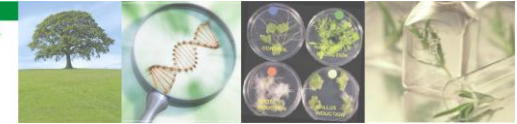
Therefore, the approach to Portman's design is to make the users aware of the surroundings within the building, expressing the volumetric spaces used.



Illustration 3.3.6: The Constitutional Court's concourse used as an exhibition space in Johannesburg (Noble 2004: 21).



Illustration 3.3.7: The Peachtree Plaza Hotel in Atlanta designed by Portman (Portman 1976: 119).



Symbols or decorative elements which add to the layers of experience can also be used as a technique. Alchemical symbols on the elevator doors are used at the Mellon Institute. These chemical signs on the doors symbolise important stepping-stones in the development of scientific thought and research in chemistry. Therefore, such approach keeps the users of the building in touch to chemistry while waiting for by the lit core.

3.3.4 A social structure

Research is a social process where the need for researchers to interact among themselves forms part of their daily routine. “Modern science is an intensely social activity. The most productive and successful scientists are intimately familiar with both the substance and style of each other's work. They display an astonishing capacity to adopt new research approaches and tools as quickly as they become available. Thus, science functions best when it is supported by architecture that facilitates both structured and informal interaction, flexible use of space, and sharing of resources.” (Watch: 2007, n.p.) Therefore, research institute should encourage formal and informal interaction, thus creating a successful and productive environment.

3.3.5 Order as an Architectural Approach

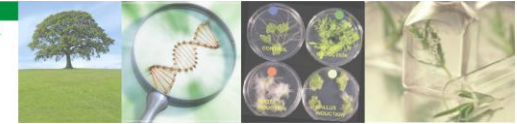
Architecture relies on a logic and coherence. “Order helps to confirm which spaces are more important, thereby, establishing a hierarchy. In addition, order clarifies organisational principles and facilitates the resolution and making of space” (Righini 2000:47). The ordering of spaces therefore allows the users to navigate through the building easily and facilitate movement. In the proposed facility, the positioning of the laboratories should be planned properly for security purpose



Illustration 3.3.8: Elevator doors on the main floor at the Mellon Institute with Alchemical Symbols on them (Weidlein 1973: 22)



Illustration 3.3.9: Lounge and meeting pods at the Plant Science Centre in USA (Mackeith 2002: 158)

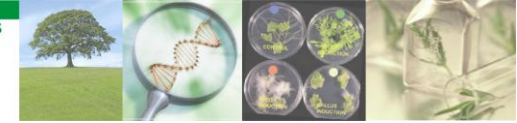


3.4 Conclusions

By designing each component of the new Botanical Biotechnology Institute separately, a unique form specific to every function is generated. These forms can then be arranged according to the requirements of the design brief and its concepts, generating an overall form of the building. The massing of such a building will maintain the legibility of each component in the Institute, thus facilitating the orientation and ordering of spaces. Laboratory spaces need to be flexible due to the constant change in experiment type and equipments. Each head of research has his or her own concept as to how the office component of a laboratory should function. Some prefer openness and transparency where more exchange of ideas can occur while others prefer cellularised offices where individual research thoughts can happen. Therefore, there should be an amalgamation of open and closed offices.

The need for energy conservation in a research institute is critical. Extroverted spaces such as offices and other public realms should be orientated to facilitate natural ventilation and lighting while promoting a humane working environment, compared to laboratory spaces which are more introverted due to the service requirements required and security reason. A new approach should be investigated to the planning of the new institute specially the relationship between laboratories and offices.

In research fields, the adage 'time is money' has significant relevance. Though funding is available, it is not open ended. A positive research output within a short time is the goal. Inter- and multidisciplinary interaction would therefore have a positive impact on research projects (Watch 2007: n.p). The success of a research institute would then be where formal and informal interactions are facilitated.



Chapter 4- Precedent Studies

4.1 Introduction

Research centres in the agricultural field are becoming vital tools for the understanding and exploration of new possibilities for the survival of mankind. Such a centre should explore specimens with the intention of improving or use its characteristics for another purpose. Many countries are investing in research as it was realised that agriculture is facing serious issues globally. The precedents therefore focus mainly on plant research facilities namely: The IBN-DLO Project in the Netherlands, The Donald Danforth Plant Science Centre in St. Louis and the Neuroscience Institute in California.

The reasons for choosing each of those precedents are:

- Institute of Forestry and Nature Research (IBN- DLO), Wageningen, Netherlands; 1994-1998; designed by Stefan Behnisch, of Behnisch, Behnisch & Partners

Reasons for Choice:

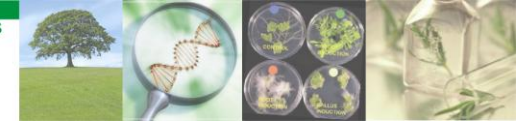
The division of components

The human environment created

The sustainable design approach



Illustration 4.1.1: The IBN-DLO Project in Wageningen, Netherlands (Kandzia 1999: 45)



- Donald Danforth Plant Science Centre, St Louis, USA; 1998-2001; designed by Nicholas Grimshaw and Partners (NGP) in association with HOK Architects

Reasons for Choice:

The use of atrium as a unifying element in the design.

The functionality of offices in lab spaces.

- Neurosciences Institute (NSI), California, USA- designed by Tod Williams Billie Tsien & Associates

Reasons for Choice:

The scattered design elements on the site.

The open plaza as a unifying element

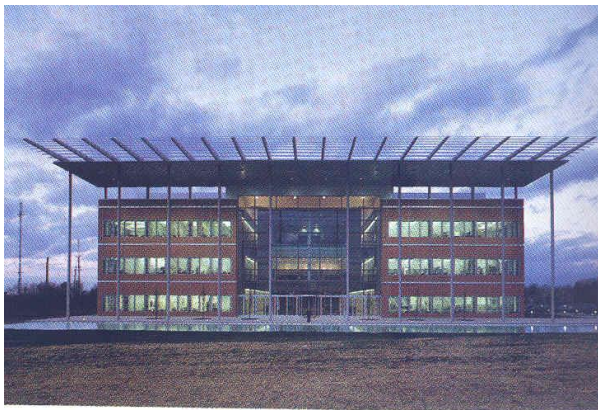


Illustration 4.1.2: Nicholas Grimshaw's Plant Science Centre, St Louis, USA (Mackeith 2002: 154)

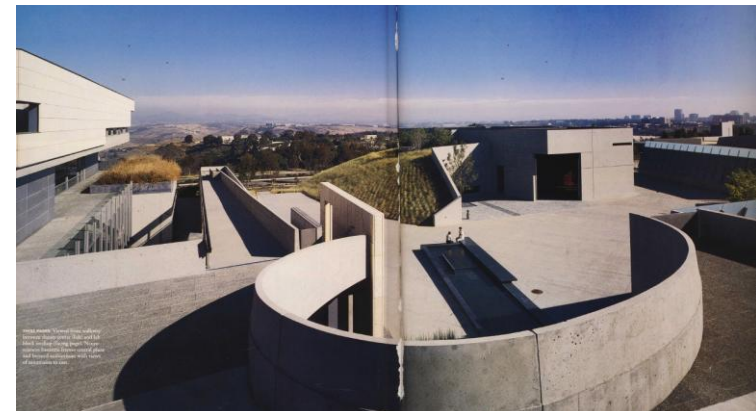
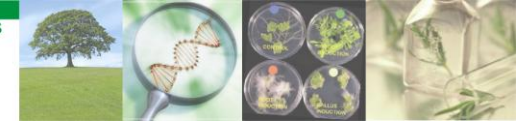


Illustration 4.1.3: Panoramic View overlooking the landscape at the NSI, California, USA (Dietsch 1996: 82-83).



4.2 Institute of Forestry and Nature Research (IBN- DLO), Wageningen, Netherlands- designed by Stefan Behnisch, of Behnisch, Behnisch & Partners- 1994-1998

4.2.1 An Introduction to the Project

With 70% of its surface area occupied by people, territorial management is of main concern for the Dutch in the Netherlands. A research institute specialising in forestry and nature research was built following a pilot project which targets the respect for the environment. Formerly, the institute's staff had been spread out in establishments over the province of Gelderland. The new project converges all the dispersed functions in one building.

Stefan Behnisch and his architects won the competition to design this new building. Their scheme was based on minimising embodied consumed energy, avoiding toxic products, saving water and allowing for any eventual recycling. This dictated the choice of forms and materials by ecological and economic considerations. It makes *“the building deliberately principle- rather than image-driven, the image being the result of the process.”* (Jones 2000: p28).

The design was a pilot project in sustainable and user-friendly architecture for the Dutch Ministry of Housing and the Environment. *“Form and function, inside and outside flow together- in this delightful building, where earth scientists conduct their research in appropriately Eden-like surroundings.”* (Source: Metz T 2000: p97). Michael Singer who is an artist was also involved in the design and his aim was to give the gardens their own ambience.

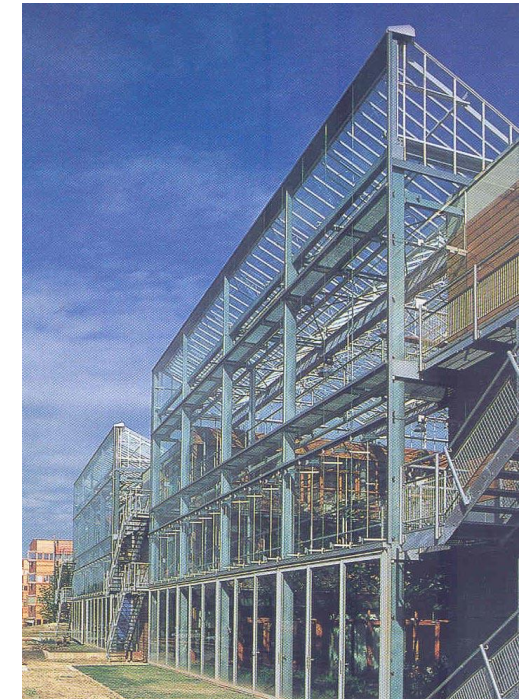
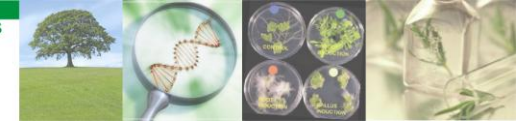


Illustration 4.2.1: Galvanised steet structure framing the courtyard spaces facing the road. (Sowa 1999:109)



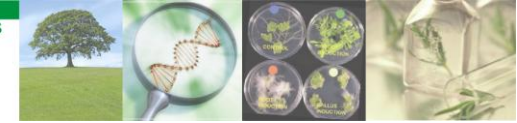
4.2.2 The Brief

Following the aims of the Rio Summit, the institute decided to make serious example of ecological planning. *“It was to show that environmentally- conscious architecture can be achieved within normal cost limits, and although the building was to represent the ecological concerns of the institute, empty Eco- rhetoric was to be avoided.”* (Jones 2000: p28). Thus, the scheme had to address and apply the serious issues of sustainability and not merely conceptual approach towards it.

4.2.3 Design Concepts

“We, as architects, are driven by the belief that our surroundings directly influence the quality of our lives, whether in the work place, at home or in the public spaces in between. This emphasis on the social dimension is fundamental to our design philosophy, which takes as its starting point the acknowledgement that architecture is generated by the needs of people, needs that may be spiritual as well as being material.”(Source: www.behnisch.com). The aim is to respond uniquely to specific demands of project and place. The result is a building which becomes over time a familiar and symbolic landmark, respecting the ‘genus loci’. They stress that *“all architects should be practicing responsibility,”* (Source: www.genzyme.com).

Behnisch differentiates the two main schools of thought in green design: the Norman Foster and Soleri views. *“There is the Norman Foster view, which says you can solve ecological problems with more technology, or the Soleri view that says: no technology. We are in the middle, but my sympathy is with Soleri. I don’t want to change our lives or go back to the Stone Age, but if we are prepared to accept*



that it's warmer in summer and cooler in winter, I am convinced that we can attain an acceptable degree of comfort by following the rules of nature.” (Source: Metz T 2000:p103)

“The technology is very old and very new at the same time,” says Behnisch. He also argues that “the concepts- local materials, natural ventilation- have been around for centuries, we merely adapted them to modern times (*illustration 4.2.2*). But the execution was like building the Eiffel Tower, or the first skyscraper: we figured everything out from scratch.” (Source: Metz 2000:p103)

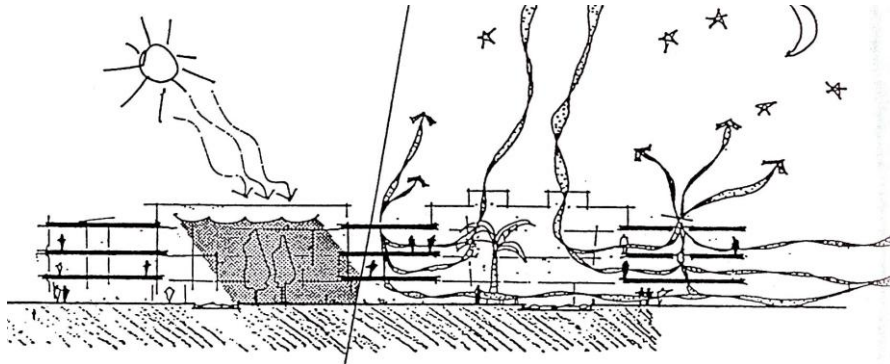
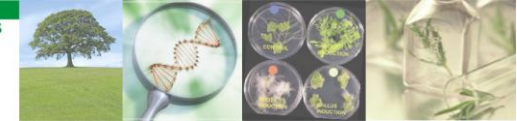


Illustration 4.2.2: Using the rule of nature with embodied energy absorbing heat during the day and releasing them at night. (Kandzia 1999: 48)

4.2.4 Site Characteristics

The IBN's Institute's new building is located to the north of Wageningen, close to other existing agricultural centres and greenhouses. The site was a used up field due to intensive agriculture. Its refurbishment was the institute's intention, and the surroundings would provide development of experimental ecological gardens creating a green corridor between the Rhine Valley and the Hoge Veluwe Park. The aim was to make this green corridor as protected ecological areas and allow plants and animals to spread, thus forming a network (Source: Jones 2000: p28).



4.2.5 Spatial arrangement of the accommodation

The IBN-DLO building is shaped like an E, with offices in the three “fingers” and two glazed gardens in between (*illustration 4.2.3*). The north facing backbone houses the laboratories that include standard and climatized laboratories. The standard laboratories with openable windows are located at the extreme back of the building, allowing light and natural ventilation to flow through the building. The temperature controlled labs are recessed at the back with a long corridor as accessed to both laboratories. The former rely on light temperature controlled devices which regulates the characteristics of the spaces.

Three wings of the double loaded offices extend southward from the spine. The architectural innovation lies in the human environment that was created in the scheme. Behnisch was strict on providing a perfect, humane type of office environment and this was achieved through green spaces in between each office block.

The south facing fingertips house a meeting room, a library and a restaurant. A defined organic patterned concrete pathway leads from the entrance past the reception area, across the office wings, and through the green spaces which weaves indoors and outdoors together. The gardens are not just for admiration purposes but are to be treated as an extension of the workplace for lunch, meetings or simply for reading. Staff can view the courtyard spaces through their intimate offices. The desire was to provide a home, protection and peace for the staff members as well as for many plants, and native trees, bushes and grasses.

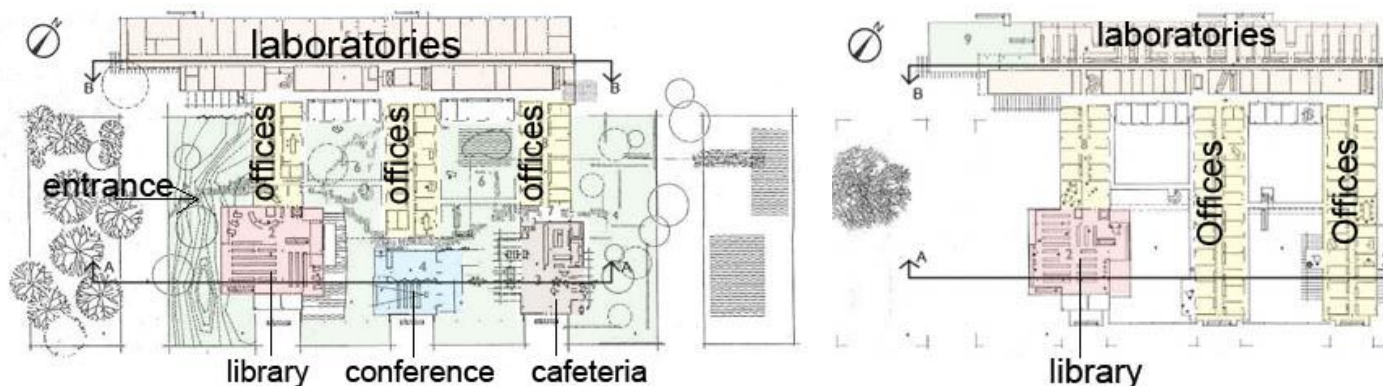
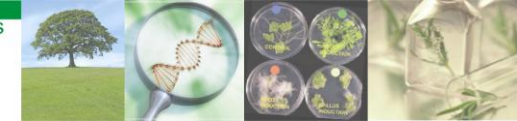


Illustration 4.2.3: E-shape plan of the IBN-DLO facility with ground floor housing library, conference, cafeteria, offices and laboratories while the first floor houses mainly laboratories and offices with courtyard spaces in between (Jones 2001: 30)



4.2.6 Critical Assessments: Positive Form

The E shaped building allows a simple construction grid which allows for extension if necessary by lengthening the spine and adding more wings. This economical construction system gives the architect the opportunity to explore and encourages the client to invest more into materials and finishes since construction is costing less.

The offices are a separate component and allow natural ventilation and natural light to penetrate the building, thus reducing the consumed energy by the institute. Communal facilities are located at the ends of the office components, encouraging movement along each wing (*illustration 4.2.4*).

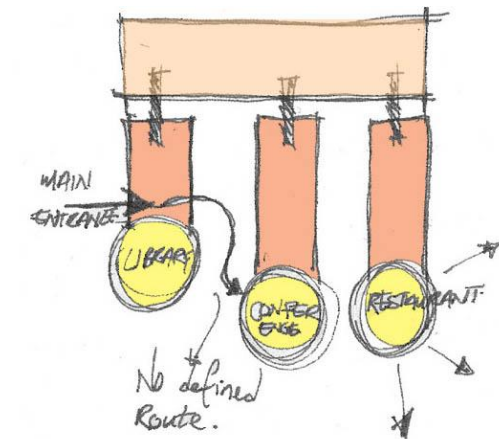


Illustration 4.2.4: Schematic plan illustrating communal functions at each ends of the offices (Source: drawn by Author).

Garden

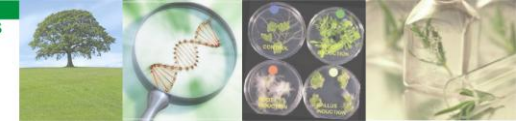
The gardens houses ecological experiments where samples (plants) become a welcoming feature providing views and recreation for the workers (*see illustration 4.2.5, 4.2.6 and 4.2.7*). Particular attention has been given to working conditions through the building. The gardens also allow fresh air to circulate through the office wings while during hot weather it humidifies and cools the air. The covered gardens between the wings of the offices help cut down heating and lighting costs. The courtyard spaces become meeting spaces for any staff member, where integration between various hierarchical members can interact.



Illustration 4.2.5: Human relationship with nature in the office wings with views and access to the courtyard spaces (Metz 2000: 103)

Illustration 4.2.6: The continuity of natural plants such as creepers onto the wall of the office wings (Jones 2001: 31).





Materials

Stefan Behnisch: “*Our office is known for green design*” (Source: Metz T 2000:p97). Essential research into materials and its causes during and after production was carried out highlighting recycling on the environment. Short pieces of wooden surfaces were made for internal surfaces rather than long planks so that as little of the tree as possible was wasted. Wherever possible, local woods were used to reduce transport costs.

At some point, the smooth/rough surface from plants was used to add beauty to surfaces. Creeper vines are gradually taking over the plywood wall of the library’s poolside terrace, and tendrils of a passion flower vine are making their way along the walkway which traverses the western garden (*illustration 4.2.8*).



Illustration 4.2.7: Meeting point in the courtyard between staff member (Sowa 1999: 109)

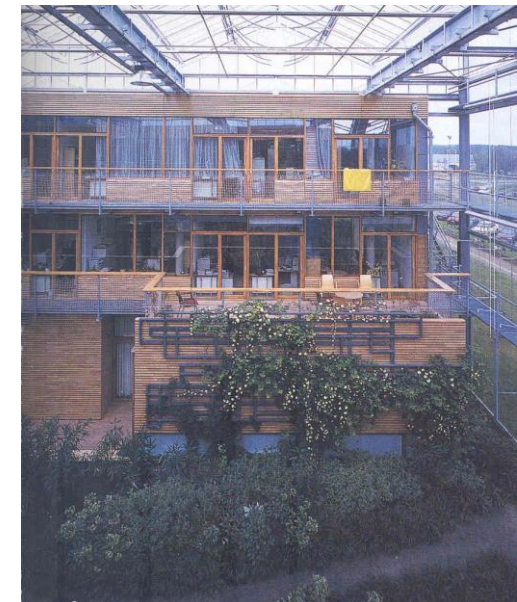
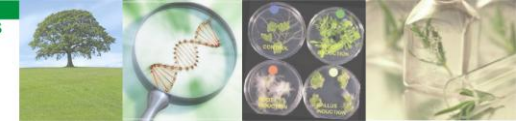


Illustration 4.2.8: Timber as wall finishes reduces embodied energy (Jones 2001: 31)



Flexibility

The design of the laboratory spaces in terms of planning allows a highly flexible space. By having the offices within the laboratory compartment, the latter is allowed to grow with time depending on the type of experimentations being carried out.

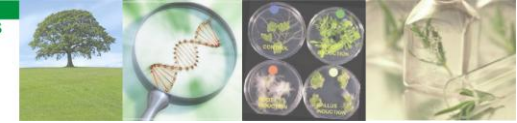
4.2.7 Critical Assessment: Negative

Security

In terms of security, the public is allowed to flow through the building. The IBN-DLO scheme is very permeable. The conference and restaurant that are located on the ground floor are at close proximity to the offices. There is no barrier preventing people from these public realms to reach the offices through the courtyard spaces.

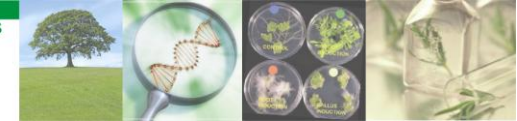
Planning

Each office has a view to the courtyards. However, for one to reach any of these offices, one must use the endless corridors. They are long, and terminate to staircases that could have acted as a feature.



4.2.8 Conclusions towards the design of a Botanical Biotechnology Institute

- Choosing a site where there are existing related research facilities is important. As discussed in this example, the IBN-DLO scheme is situated in a surrounding development for experimental ecological gardens and the aim was to create a green corridor. The site was chosen as part of a research devoted precinct with the intention of creating a high quality research precinct in the long term.
- Location of offices is critical. Having a separate wing as an office for the researchers enables them to move more freely and to keep in contact in other researchers and staff members.
- The relationship between courtyard spaces with the intention to create a human environment where users feel closer to nature. It also promotes natural ventilation and light through spaces situated next to it.
- The shape of the laboratories should be regular, simple with an economical grid construction. The massing or form of the building should clearly reflect the programme. Rather than squashing the institute into a single form, forcing its various facilities to be accommodated on standardised floors, each component should be housed in a form specific to its unique function. These various forms would then be arranged, creating the overall configuration of the institute.
- Promoting the use of local materials which would mean less transport expenditure. Furthermore, the availability of materials existing on the chosen site should be investigated.
- Security throughout the building is of a high priority. The public should not be allowed to penetrate everywhere in the building.



4.3 Donald Danforth Plant Science Centre, St. Louis, USA- Nicholas Grimshaw and Partners (NGP) in association with HOK Architects- 1998-2001

4.3.1 An Introduction to the Project

The Donald Danforth Plant Science Centre is located at the point where the Mississippi and Missouri rivers meet in the city of St Louis. The city centre is struggling in the continuous decline of the post war population (*source: Donnelly 2002: p22*). On the contrary, the metropolitan region continues to expand from residential to commercial suburbs. St Louis is known to be an agricultural node. It serves as a focus for the agricultural and botanical research activities of a broad number of civic, academic and corporate institutions throughout the Midwest, and a further growth in such fields is to be anticipated.

The Danforth Foundation which was created from the former president and chairman of Nestle-Purina, a leading worldwide producer of feed grains, pet foods and cereals, established an independent, non-profit institution for basic plant science research known as the Danforth Centre. The partners of this facility are the Missouri Botanical Garden, the Monsanto Company, Purdue University, University of Illinois, University of Missouri and the Washington University in St Louis. The foundation established the Plant Science Centre initiative through a \$60million donation for the interest in agriculture, nutrition and health.



Illustration 4.3.1: The Danforth Centre treat the background with greenhouses facing the rear of the building (Mackeith 2002: 156).



4.3.2 The Brief

The Donald Danforth Plant Science Centre laid out design goals within their brief: “First, they wished to create an open and accessible environment, giving the public maximum opportunity to use its facility. Second, they wanted to establish a working environment that would allow scientists to explore and exchange ideas within a community dedicated to advancing the science and understanding of man’s reliance on plants.” (Source: www.danforth.org). The aim of this research institute is to “*significantly increase our understanding of basic plant biology through research and training.*” (Source: Mackeith, 2002:p154)

A limited invited competition was organised from which NGP was awarded the commission, with HOK Architects who were designated associate for technical and landscape consultancy.

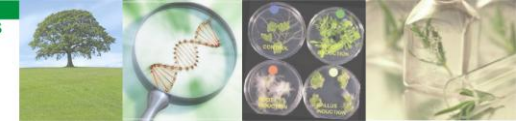
In the first stage of the project, technical consultancy for the research laboratories and consultant in workplace ecology was conducted for the perspectives on an ideal scientific research space. There was also an “*interest in the building’s potential to address environmental issues through the integration of sustainable design principles.*” (Source: Donnelly 2002: p24)

4.3.3 Design Concepts

The “poetic potential of designing with the technology of climate and light” (source: Donnelly 2002: p27) is expressed in the NGP’s scheme Through its sitting of the building, NGP merged formal principles in terms of hierarchy and the use of materials, producing a representation for a collaborative research laboratory that possesses civic presence.



Illustration 4.3.2: The dramatic sun-control device sitting above the building (Mackeith 2002: 155)



A grand portico is provided to the street on the south side of the building while sun-control devices sit above the entrance and terminate the verticality of the building. A reflecting pool is used to provide the contrast between natural and the manmade (see *illustration 4.3.2 on page 36*).

4.3.4 Site Characteristics

The site is situated in a moderately open, acontextual terrain at the developing edge of St Louis County. It is in close proximity to the downtown area, major highways and the airport (*illustration 4.3.3*). However, the setting also meant the research centre was located in an area where the dominant typological and aesthetic norm for a building of this size has to be more like an office building which is not only due to the local zoning, building regulations and the parking necessity but also by ideas of civic representations. Existing spaces surrounding the site are a church and a sports field. There is hardly any infrastructure in this new developing node. The site itself is 40 acres in extent which allows for flexibility and expansion.

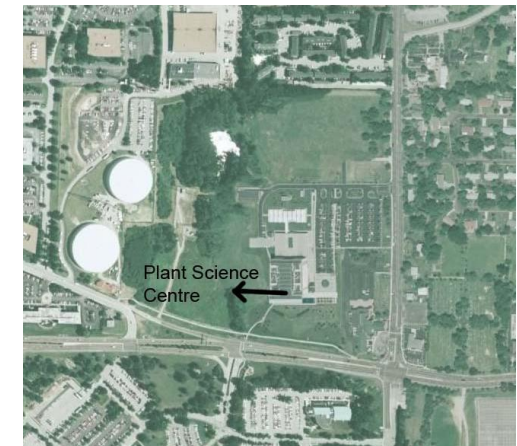


Illustration 4.3.3: The Context around the Plant Science Centre (Source: Google Earth)

4.3.5 Spatial Arrangement of the Accommodation

Research centres are complex buildings that are expensive to build and to maintain. Equipment is also costly. This engages architects to design a simple plan that will be cost effective while respecting the practicality involved (*illustration 4.3.4*). “Employing formal organizing principals, NGP and HOK were able to design environments that will engender collaborations among researchers while remaining publicly accessible.” (source: Mackeith 2002:p158)

The total floor area of the Danforth Centre is 11,850m² and includes the following spaces:

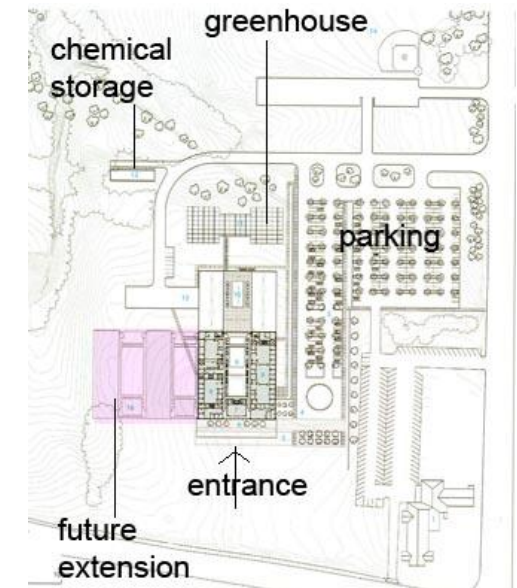
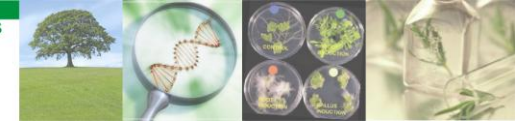


Illustration 4.3.4: General planning on site (Donnelly 2002: 20-29)



- Laboratory- for the research in various aspects of plant sciences (*illustration 4.3.5*)
- Lab support- flexible spaces used for keeping high tech equipments or for further research procedures.
- Scientists' laboratory office- Used as offices spaces for scientists but also to carry out reports.
- Media Kitchen- deliveries of specimen are kept in such a space for unpacking, sterilise and storage before moving to laboratories.

With the building set away from the noisy road, parking for staff and visitors is situated at the corner of the secondary and tertiary road. The main road is the one running east- west. Scientists need quietness to work and this is achieved partly by moving the building away from the main and secondary roads. Visitors and staff can be dropped off by the main entrance facing south. As a welcoming feature to the research centre, a reflecting pool flows along the passage to the entrance. Storage for hazardous materials is situated far away from the building due to flammable materials that are stored which might cause explosion (*see illustration 4.3.4 on page 37*). In such cases, it is preferable to store such products away from the main building.

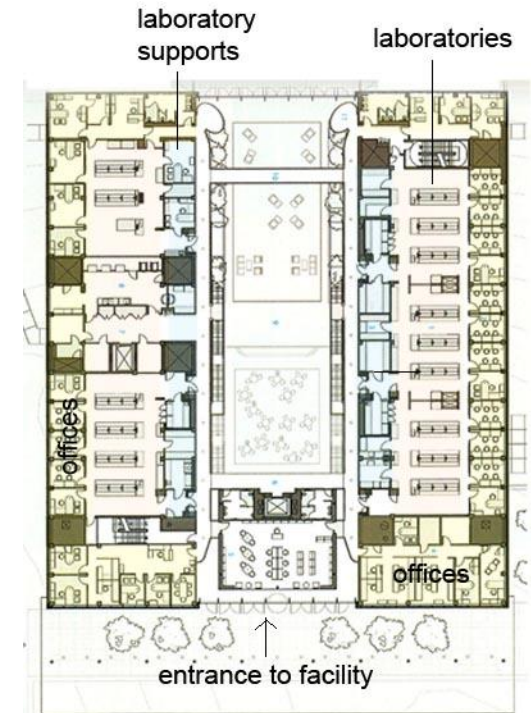
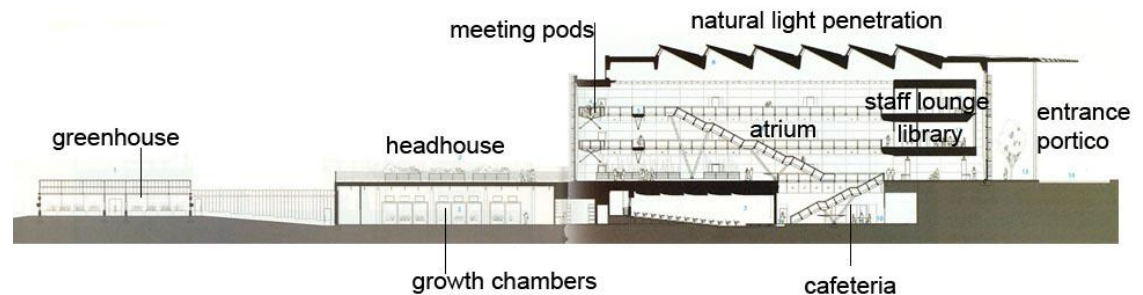
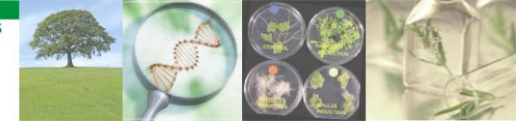


Illustration 4.3.5: Plan of Donforth Plant Science centre with an atrium at the centre and two identical wings on both sides (Donnelly 2002: 24)

Structured curtain walls that are supported by shaped, rolled steel mullions are used on the north and south walls of the atrium (*illustration 4.3.6*) while to celebrate the southern entrance is a dramatic horizontal brise soleil which provides shade at the upper levels but also serves as the building's cornice, ends the verticality of the building to the sky.

Illustration 4.3.6: Section through the atrium illustrating the various spaces within the facility (Donnelly 2002: 24)





The Donald Danforth Plant Science Centre provides outstanding research and training facilities including a library and a lecture auditorium with video conferencing capabilities. Compartmentalised greenhouses and environmentally controlled growth chambers and growth rooms have also been provided.

The design is displayed with the spatial elements symmetrically around the north-south axis. This allows for a cost effective construction but also resolves issues such as ducting and other services. The articulation of spaces works from the public to private spaces. The public space on the lower ground floor includes an auditorium with the cafeteria as a meeting point.

Innovative spaces were successfully created within the Danforth Centre. One consists of an atrium which expresses itself in its volume and linkages where scientists and the public who use the research centre can interact (*illustration 4.4.7 and illustration 4.4.8*). Visitors come through the south entrance on the ground floor and either goes to the auditorium and café that are on the lower ground floor or use the atrium as a meeting point by the courtyard spaces. Two laboratory wings run along the east-west side of the atrium which is accessed by staircases on the side of the atrium. The south light warms up the administration and office suits that are adjacent to the entrance. The flower pots on the ground floor separate the public from the private spaces. It allows the public realm to function in a simple and elegant manner where the plants hide the passage or doors that are situated along the private corridor.

The laboratory design is duplicated on the first and second floor with offices at the end of the laboratory facing the east-west orientation. Each laboratory block is linked together by a series of walkways, bridges and meeting platforms, which provide a semi-private space for scientists to meet informally for

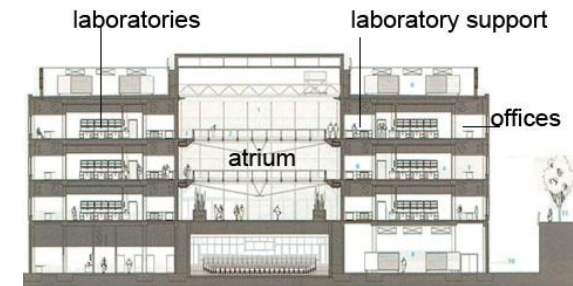


Illustration 4.3.7: Section illustrating relationship between laboratories, offices and the atrium (Donnelly 2002: 24)

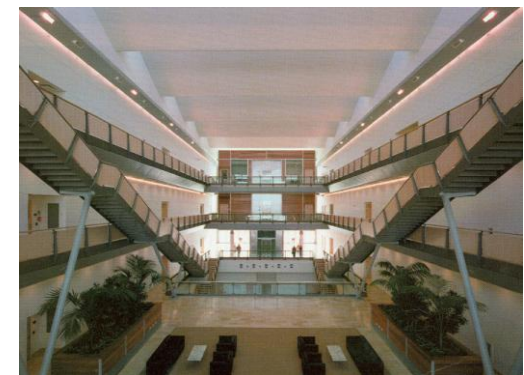
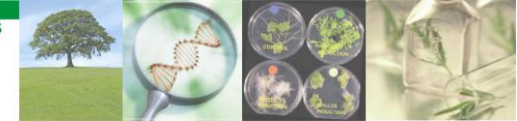


Illustration 4.3.8: The main entrance with the library and lounge above it as pods suspended above (Mackeith 2002: 158)



the exchange of ideas away from the labs and public spaces (*illustration 4.3.9 and illustration 4.3.10*). The blocks are also linked at the south end by a freestanding pod structure that consists of semi- public areas of the library, meeting rooms and a lounge which is on the last floor. The library and lounge are easily accessible from both laboratory blocks.



Illustration 4.3.9: Cantilevered balconies, and bridges details the aesthetic and architectural aspect of the design (Mackeith 2002: 158)



Illustration 4.3.10: Private meeting spaces and bridges (Donnelly 2002: 23).

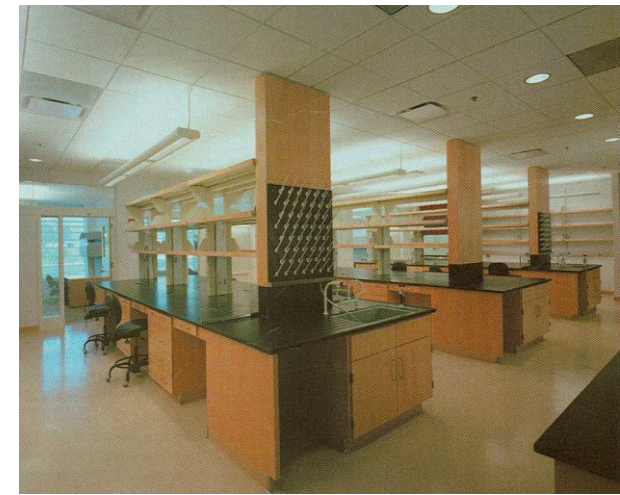
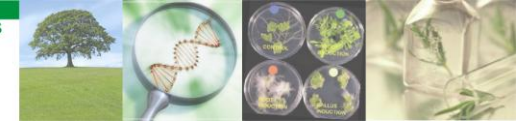


Illustration 4.3.11: A typical laboratory space at the Danforth Centre that is under air conditioning system (Donnelly 2002: 26)



4.3.6 Critical Assessments: Positive

Flexibility of Site

Selecting a site of 40 acres allows for flexibility and expansion of the centre. With time, such facilities have to expand due to the need for future research. NGP's scheme allow for expansion of the building using the same building layout of an atrium surrounded by two laboratory wings.

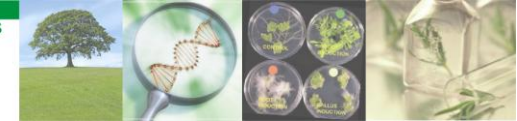
The Atrium

The skylights allow natural light to penetrate through the atrium, minimising the use of artificial lights in the atrium.

The north façade of the atrium is fully glazed with possibility of opening doors not only to access the greenhouses but also allows natural ventilation into the atrium. This component of the building is enclosed by a ridged north light roof which improves this light and airy internal garden concept contributing to the energy savings in the atrium. Laboratories need regulated temperatures, therefore natural ventilation strategies may not be applicable in such conditions.

Planning

Growth chambers are located underneath the headhouse which is used as a platform for the display of final plant products that have been work out in the building (*illustration 4.3.6*). The growth chambers are enclosed spaces to allow plants that are still fragile to grow in a controlled room temperature. As



they grow and gain strength they are transferred to the greenhouses which are not temperature controlled.

The terracotta panels act as a rain-screen wall system with extruded aluminum sections supporting them from the wall system (*illustration 4.3.12*). This high performance assembly responds efficiently to rainwater, water vapour, temperature and air transmissions. The panels are placed in such a way that there is an air cavity in between the wall and the terracotta panels. The air cavity acts as a buffer from heat gain in the building. The window openings on the east and west side of the building are crossed horizontally by aluminum louvers that modulate daylight while still permitting the occupants to see outside. These shading devices were designed and fixed to reduce the radiant heat gain. They were designed for the peak loading conditions which is at 5pm at summer solstice.



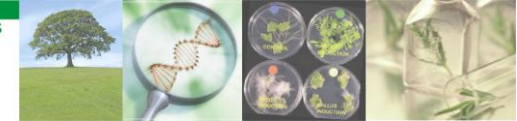
Meeting Nodes

The scheme provided spaces as meeting nodes for the staff and visitors. On the ground floor, seating is provided in the atrium as a meeting space between researchers and visitors. Meeting nodes for researchers are designed as suspended pods that become a feature in the atrium but as an important element for the staff.

4.3.7 Critical Assessments: Negative

The scheme consists of various components bind together to form a box. The Danforth Centre which is an agricultural research centre has only views to the natural outside environment. The internal atrium consisting of planters are merely dressed up elements. There is no symbolic expression that features

Illustration 4.3.12: Uniform treatment of the facades using terracotta panels (Donnelly 2002: 26)



nature within the building. The amount of natural elements used in the building is extremely low compared to the man-made ones. A high technology building doesn't mean that nature should be excluded out of it.

The offices are accessed by going through the laboratory spaces (illustration 4.3.13), thus using the same volumetric spaces. Furthermore, the flexibility of the laboratory is reduced due to this planning approach.

4.3.8 Conclusions towards the design of a Botanical Biotechnology Institute

- The massing or form of the building should clearly reflect the programme of the Institute. Rather than squashing such a facility into a single form, forcing its various facilities to be accommodated on standardised floors, each component should be housed in a form specific to its unique function. These various forms would then be arranged, creating the overall configuration of the institute.
- In some cases, clients usually don't think about the flexibility aspect of the building. The architect should propose such considerations for the proposed design.

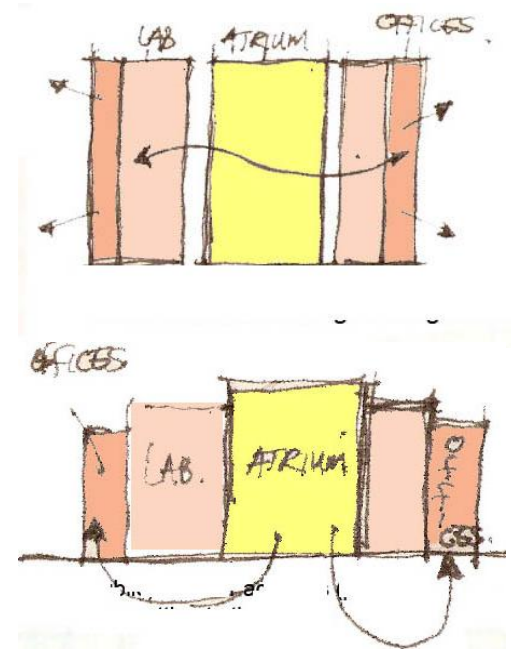
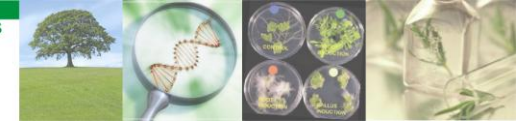


Illustration 4.3.13: Schematic plan (above) and section (below) illustrating circulation from atrium (public) to other activities (private). Note that users should go through the laboratories before getting into the offices (Source: drawn by Author)



4.4 Neurosciences Institute (NSI), California, United States- designed by Tod Williams Billie Tsien & Associates

4.4.1 An Introduction to the Project

The Neurosciences Institute in La Jolla, California studies how human beings perceive, imagine, learn and remember. It is an institutional project of complexity due to the nature of the building and the servicing required and of its prominence. The Institute was initially housed at the Rockefeller University campus in New York City. For the benefit of the scientific community, Scripps Research Institute invited the NSI to move on leased land adjacent to the Scripps campus. The generous institute provided the funding for the construction of the facility's new complex.

4.4.2 The Brief

Williams & Tsien were selected for the job by a committee comprising of local personalities and representatives from both institutions. The staff representatives knew that the architects would take the project very seriously and that there would not be any driving force towards any kind of monumentality and stylistic belief. They wanted a sense of commitment to excellence and artistic vision.” (Source: Freiman 1995: p76).

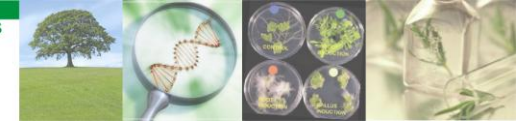
The brief was to design a building for the Neurosciences Institute that meets the Institute's needs and also its aspirations. The architects worked with Dr. Gerald M. Eldelman who was the founder of the Neurosciences Institute, insisted on the fact that “because creativity necessarily begins with the self, we wanted to make a place for selfish individual creators, with no rules and no politics,” (Source: Freiman



Illustration 4.4.1: The contrast between solid concrete elements, water and redwood slates create a humanism environment (Dietsch 1996: 85)



Illustration 4.4.2: The view of mountains to the east (Dietsch 1996: 82)



1995: p76). He wanted to make a monastery dedicated to science. The founder wanted to create a compound that would be separate from the surroundings but at the same time opening outward to the view of the hillside. “Every vista, every salient characteristic or place must be beautiful or interesting. I didn’t want people to be overwhelmed in one view and disappointed in another” insisted Eldelman (Source: Freiman Z 1995: p77).

4.4.3 Design Concepts

Being close to the Salk Institute, the architects needed to compete and create a new architectural approach. They rejected the symmetry and frontality of Khan’s design which they characterised as oppressive. It was more towards a reserved, site specific architecture that promotes social interaction.

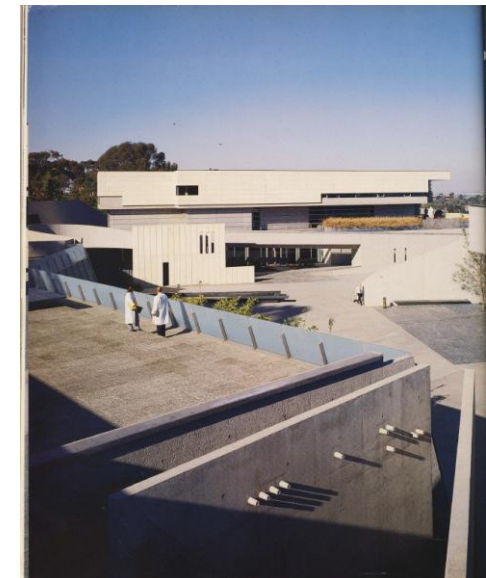
Tod Williams created three buildings that are hardly noticeable from the street (*illustration 4.4.3*). These structures are: a raised Theory Centre, a U-shaped line of buildings oriented east towards the mountains is the laboratory wing and an auditorium at the centre of the scheme surrounded by a plaza. These are sunken into the landscape where portions of the building can only be seen from walkways, balconies, staircases and ramps descending into a central courtyard.

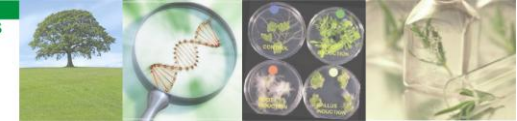
The paved central plaza is used as an informal meeting point for scientists to share information. “The space between the buildings is the foundation of our design,” William T (Source: Dietsch D.K 1996: p91). It offers inland views towards the San Jacinto and Santa Rosa mountains to the east.



Illustration 4.4.3: The rear façade of the auditorium (left), the promenade from plaza (centre) and cantilevered theory centre (right); (Dietsch 1996: 89)

Illustration 4.4.4: The Theory Centre with the curved courtyard linking the various spaces (Dietsch 1996: 84).





4.4.4 Site Characteristics

The NSI complex is located in the hillside across from the Scripps campus on the North Torrey Road with a tunnel connecting these two institutes. It is also less than a mile from the Salk Institute for Biological Sciences designed by Louis Khan (*illustration 4.4.5*).

4.4.5 Spatial arrangement of the accommodation

The most important gathering space identified is located between the Theory Centre and the labs known as the plaza. It is an intimately scaled circular courtyard which is overlooked by the NSI dining room on the ground floor of the Theory Centre, which also houses the offices (*illustration 4.4.5*). Occupying the centre of the plaza is an auditorium used for research presentations, a conference and as a chamber for music recitals. Eldelman thought music is an integral part of the Institute's humanist culture. Music is a relaxation for the mind and soul. The auditorium is accessed from a verandah (*illustration 4.4.5*) with gently sloping light scoop allowing natural light and hot air extraction to occur.

The Northern part of the complex is the Theory Centre and as the name suggests, it houses the theoretical part of the institute with a library, conference room, offices and the administration. The library and offices that require natural light faces north with kitchen and dining on the south overlooking the courtyard. The building is clad in light coloured fossilised limestone on the upper stories, with an ivory tower turned on its side (Source: Dietsch D.K 1996: p91). The offices for the Institute's theoretical scientists and administrative staff are located on the top two floors (*illustration 4.4.6*). The offices are suspended over a glass base containing the dining room, library and meeting rooms.

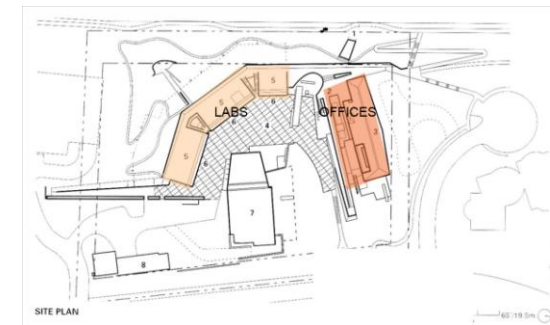


Illustration 4.4.5: Site Plan of the Neuroscience Institute with offices on the right hand side and laboratories on the other (Dietsch 1996: 93).

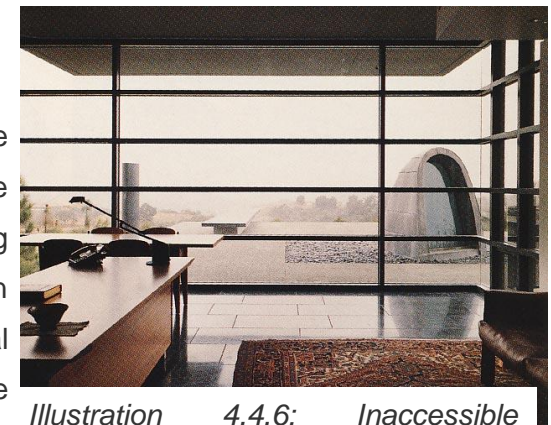
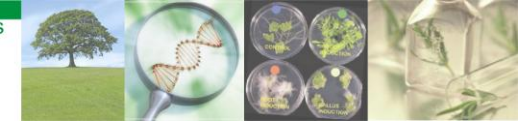


Illustration 4.4.6: Inaccessible balcony outside the Director's office with sculptural light monitor and diving board (Dietsch 1996: 91).



A U-shape structure is located on the western side of the scheme, housing the laboratories and conference rooms (*illustration 4.4.7*). It assumes a more recessive character due to its shape and exposure to the plaza with steel frame mullions and planes of glass that extend to form a parapet along a roof terrace. Staircases are inserted by the bending joints of the building forming the U-shape. These connect the terrace to the plaza below (*illustration 4.4.8, 4.4.9, and illustration 4.4.10*).

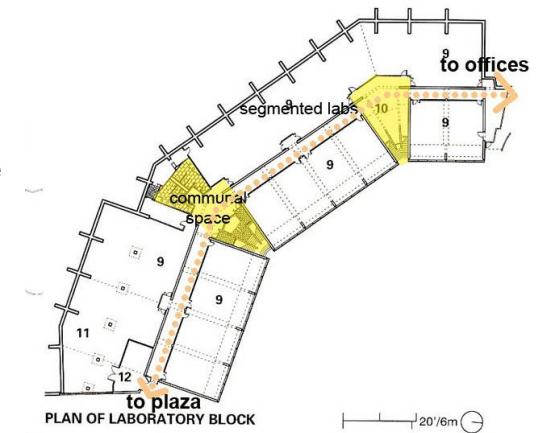


Illustration 4.4.7: Plan of Laboratory Wing at the Neuroscience Institute with communal spaces at by staircases, along the corridor to the offices. (Dietsch 1996: 89)



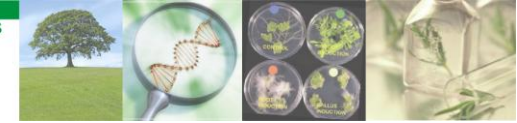
Illustration 4.4.8: The slot between staircases of lab wings (Dietsch 1996: 86).



Illustration 4.4.9: The laboratory block's glazed panels, sandblasted on top, from parapet to rooftop terrace (Dietsch 1996: 86).



Illustration 4.4.10: The laboratory wing on the left had side with angled planes of glass (Dietsch 1996: 85)



4.4.6 Critical Assessments: Positive

The Plaza

It is a poetic scheme that narrates the approach to the building with the plaza as the main focus. The plaza itself has been worked through to details with changes in paving materials and interrupted landscaping.

By defining the hierarchy of spaces in specific location the users and visitors filter through easily. The plaza acts as an external corridor linking the various spaces. Permeability through the site is successfully achieved.

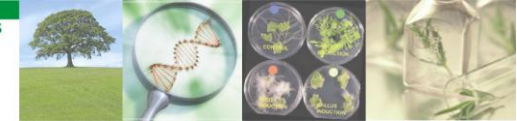
Planning

The organic form of the building is in perfect harmony with nature. The circular elements, the sculptured glass planes of the laboratory along the east side facing the plaza and the horizontality of the theory centre- all overlooking the mountains sit nicely into the landscape. By sinking the buildings into the landscape it gives privacy for the users but at the same time allow nature to step forward rather than the building.

The auditorium can function as a separate organism. This has been achieved by separating the public and private spaces.

4.4.7 Critical Assessments: Negative

The scheme seems to talk three different languages facing the plaza, with the auditorium as a large rectangular block, the Theory Centre with a tower being extruded from the first floor and the laboratories with angled glass panels. There is no continuous architectural identity except for the use of materials.

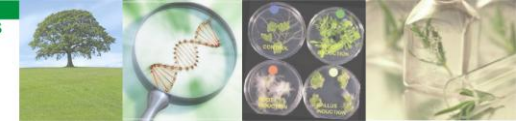


Theoretically, the plaza should function properly, with the staff and visitors using it. However, up to what point can it work practically? By having a common facility in it, such as a restaurant, the plaza could have work better.

The angular spaces between the laboratory wings by the staircases are uninviting, with little natural light penetrating through (see *illustration 4.4.8 on page 47*). Public/meeting spaces should be well lit areas, acknowledging them as important public realms.

4.4.8 Conclusions towards the design of a Botanical Biotechnology Institute

- The hierarchy of spaces is an important factor in the design of PBI. Privacy and security are important component to be considered which could lead to a fragmented building with public spaces planned away from the labs.
- To acknowledge the standard planning of laboratories and auditoria which have specific shapes and arrange them to create an overall configuration of the Institute.
- Separating public spaces (auditoria) to the private ones (offices and laboratories) can result in a separate public organism that can function on its own.
- The need for natural light to penetrate and reach public and meeting points is essential.



4.6 Overall Conclusions drawn from Precedent Studies

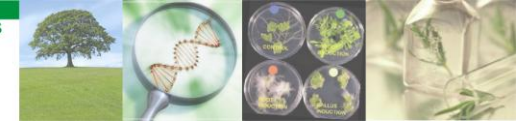
The concept for each of the precedent studies analysed is unique as each emphasizes specific components due to the client's needs or the architectural approach. However, through analysis, these have helped the author to understand the architectural requirements and/or approach for the design of a new Botanical biotechnology institute. Such approaches are discussed below:

4.6.1 Site Selection

- Research facilities are preferably located among other existing facilities where strong relationships and exchange of ideas can occur.
- In some cases, locating the proposed building near tertiary institutions would provide for greater interactions.
- The topography of the selected site should be analysed and that could inform the design approach.
- The size of the site should allow for testing fields of the various plants being examined

4.6.2 Planning

- The use of courtyard spaces promoted natural ventilation and natural light to penetrate deeper in the building. These also improve the working environment, creating a more dynamic institution.
- The approach to laboratory design is usually a rectangular box. This allows for flexibility within such spaces.
- Circulation should be designed to facilitate interactions among staff members.



- Spaces designed to specific module size allows for changes to be easily effected.

4.6.3 Servicing

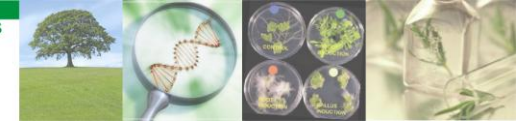
- Servicing by means of outlets from above rather than below is generally more appropriate.
- Service spaces should allow for decentralisation but also, allowing for an increase in service requirements due to expansion.
- The building's flexibility is associated to the servicing, therefore the type of servicing selected is critical

4.6.4 The Ecological Approach

- Spaces should be naturally ventilated and well lit. These reduce the energy consumption of the building.
- Laboratory spaces are artificially ventilated. However, natural light could be allowed with sunlight penetration being minimised as it increases the energy consumption within the laboratories.
- The environmental conditions of external spaces should not be neglected. The landscaping of courtyard spaces should be integrated.

4.6.5 The Humane Environment

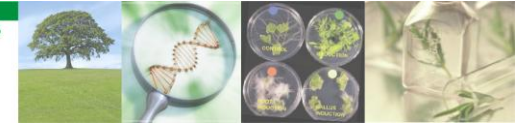
- The use of natural light is needed to create a conducive working environment.
- The need for break-away spaces that would allow private meeting points.



- Greater interactions can be achieved among staff by considering generous spaces through the use of stairs and passageways, and through thoughtful planning of innovative spaces

4.6.6 Concluding Remarks

The integration of building technology including services and architectural inputs in the design process should be closely interpreted. Various design approaches should be examined before concluding towards a solution. The proposed facility is a functional with flexible service requirements; however, the architectural input is not to create a space, but rather a place.



Chapter 5- Case Studies

5.1 Introduction

This research is aimed at the design of a Botanical Biotechnology Institute and investigations revealed that there was no facility of this nature in either Mauritius or in KwaZulu-Natal Province. However, the selected case studies deal with agricultural research, namely the Food Technology Laboratory in Mauritius and the Sugar Milling Research Institute in KwaZulu Natal. The reasons for choosing each of these case studies are:

- The Food Technology Laboratory, Reduit- Mauritius, 2005; designed by Narrain S.

Reasons for Choice:

The Food Technology Laboratory is a recently built facility that is up-to-date

It is a facility located in Mauritius allowing the researcher to understand how laboratory designs are conducted in the country. It should be noted that pictures were not allowed to be taken in this government building.

- The Sugar Milling Research Institute, Durban-South Africa, 1950

The building is related partly to the type of research that will be conducted in the proposed Botanical Biotechnology Institute. Sugarcane research is conducted at this institute

The Institute is not located in Mauritius, thus allowing the author to understand how such institutes works at an international level and the ability to compare architectural inputs.

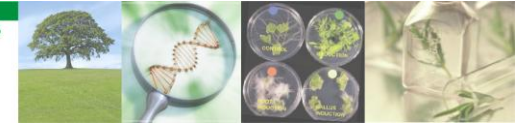
N.B: Plans and sections have not been made available, however, diagrammatic sketches have been provided to give a better understanding of how the buildings function.



Illustration 5.1.1: Case study 1: The Food Technology Laboratory at Reduit, Mauritius (Source: Author).



Illustration 5.1.2: Case study2: The Sugar Milling Research Institute in Durban, South Africa (Source: Author).



5.2 Case Study 1:

Food Technology Laboratory, in Reduit- Mauritius, 2005- designed by Narrain S.

5.2.2 An introduction to the Project

The aim of the Food Technology Laboratory is to promote analytical support services for the agricultural and food sectors whilst conducting research and development to improve the quality of food delivered to consumers. The laboratory encourages hygienic methods of production focusing on improved chemical and microbiological quality of food and food products produced by stakeholders. It also ensures safety and quality of both locally produced and imported food products and ensures that quality standards are met for export as well. It is of their duty to protect public health and to ascertain that consumers get value for money. The vision of the Food Technology Laboratory is to achieve regional and international recognition for quality analytical services to promote GAP and food safety.

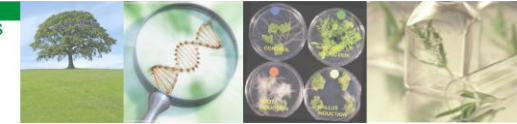
5.2.3 The Brief

The accommodation was to include a dairy section monitoring the quality and safety of milk and dairy products for the Agricultural Marketing Board (AMB), Agricultural Research and Extension Unit (AREU), small cow breeders associations, importers and stakeholders.

A seafood hub section was to analyse fish, fish products and water samples for the Sea Food Hub Division (SFHD) prior to export. Division of the Veterinary Services would analyse imported food products of animal origin for certification. A simple and economic construction was required due to the economic constraints.



Illustration 5.2.1: The Food Technology Lab clad with aluminium panels (Source: Author).



5.2.4 Design Concept

The driving concept in the building was the building norms, that is; the technical requirements for laboratory design. This resulted in a very practical building with a lot of emphasis laid on services. A simple grid structure was used.

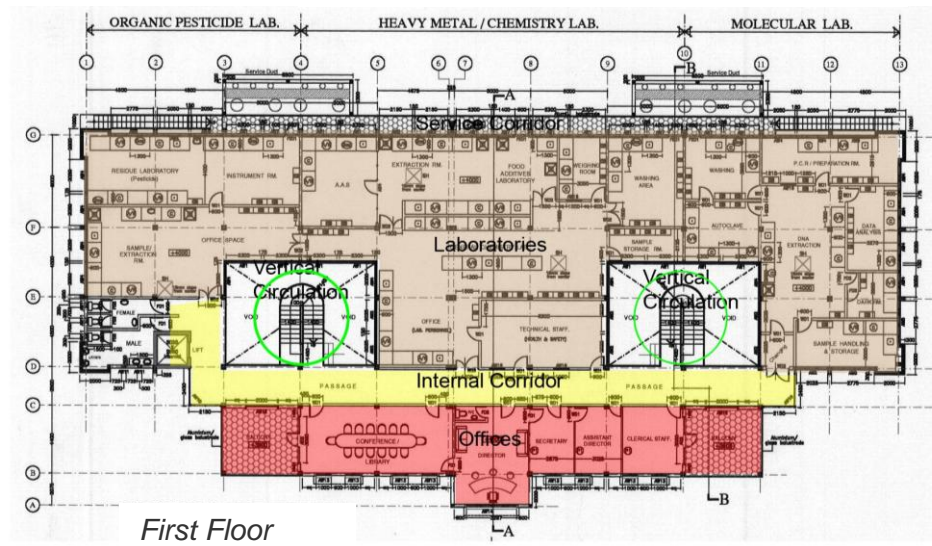
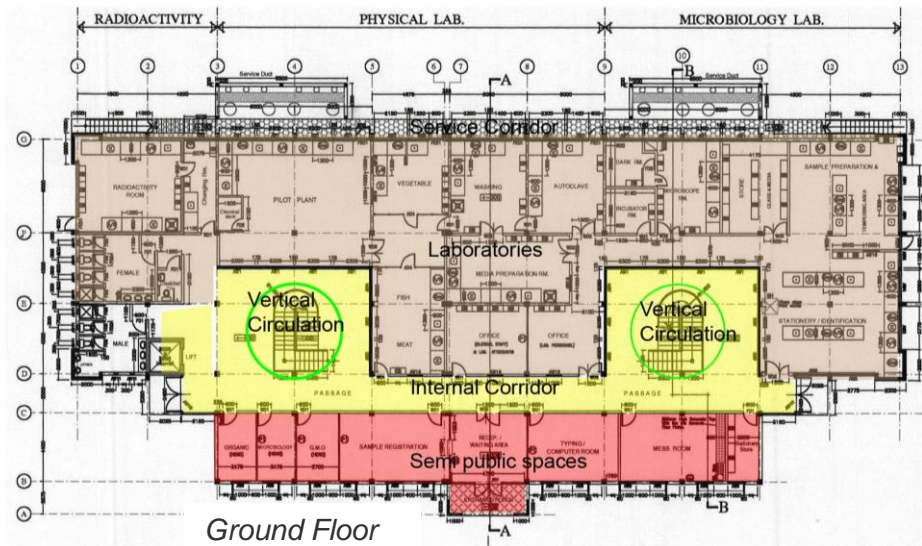
5.2.5 Spatial arrangement of the accommodation

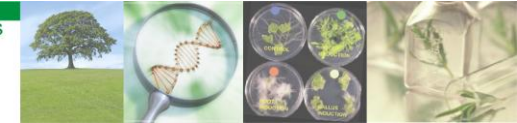
The client's request for such a lab in terms of accommodation was a microbiology lab, a physical lab, a radioactivity component, molecular lab, heavy metal/chemistry lab and organic pesticide lab. These major elements are fragmented into spaces, small and big with offices and a conference/ library room (*Illustration 5.2.2*).

Three basic elements have been used in this design:

- The semi private spaces facing the road
- The internal corridor feeding the various spaces within the building
- The laboratory block

Illustration 5.2.2: Ground and First Floor Plan with an internal corridor separating the various functions- Food Technology Lab. (Source: BSN Partnership).





Parking for staff and public is located on the south west end of the site with the service yard at the back incorporating stores, transformer and generator room, steam boiler and compressor room and an incinerator (See Illustration 5.2.3, 5.2.4 and 5.2.5). These components are detached from the building for security purposes and maintenance. The incinerator is used to burn solid elements left from the experiments. It is not utilised on a daily basis. A tank for laboratory sink waste is provided as an underground structure on the south east of the building. A truck provided by the Ministry of Environment comes every week to take those deposited waste and transported to a secure place thus minimising environmental impact.



Illustration 5.2.3: Incinerator outside the building (Source: Author).

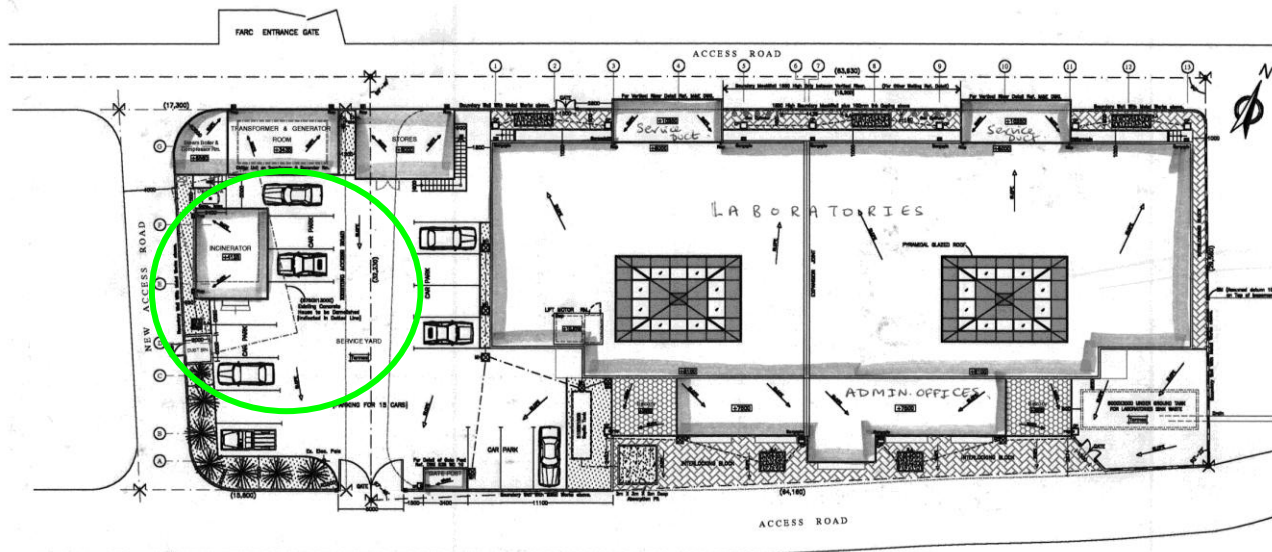
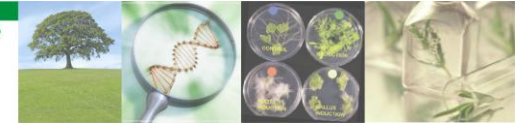


Illustration 5.2.4: Roof plan indicating location of storage and incinerator facilities (Source: BSN Partnership)



Illustration 5.2.5: Storage facility by the parking spaces (Source: Author).



Facing the street on the south east is the entrance with the reception/ waiting area. A large corridor separates the south east wing which is a public/ semi- private space to the rest of the building. The corridor is linked to two vertical staircases. The latter is defined with light wells from the roof, acknowledging the vertical movement along that corridor.

The laboratories are serviced with two service blocks along a corridor facing North West. “In our initial scheme, we provided services through the flooring, but when the engineers worked onto the project, it was suggested to have the services outside which would provide flexibility” (Narain: *personal communication*, 10th January 2008). Services through the floor require constant maintenance as bacteria can stick on the underside of the service cover. These service ducts therefore carry water, air conditioning, gas and other laboratory services needed by such a facility (*illustration 5.2.6*).

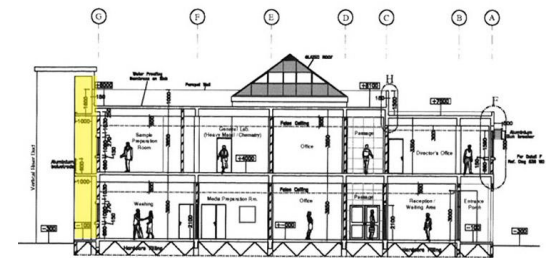


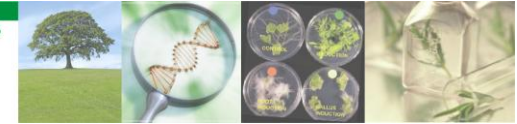
Illustration 5.2.6: Section illustrating external service walkway for servicing laboratories (Source: BSN Partnership).

5.2.6 Critical Assessments: Positive

- The use of aluminium panels on the facades reduces the thermal mass of the building
- The vertical service tower ducts are next to the labs, allowing easy access and connection to the various lab departments.
- The use of skylights above the staircases creates an important communal space

5.2.7 Critical Assessments: Negative

- The incinerator is located by the visitors' parking.
- The size of the reception area should be more reasonable. Congenial reception space usually gives a first impression to any visitors to a building.

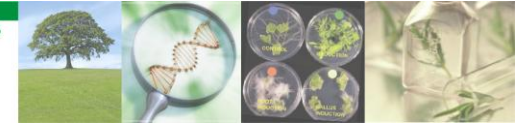


- The mess room is too small and should open up to the natural environment.
- Very few cellularised offices have been provided.
- Wasted and unused spaces within the laboratory block results in an increased energy consumption within such space

5.2.8 Conclusion from a discussion with Dr. Gopaul

The atrium was intended to be used as a meeting point but the design doesn't allow this type of event to take place. Such space is air conditioned, with no aspect related to humane environment that would promote such activity. Benches or plant pots would give that feel of an important node where researchers could meet. Currently, they can only use the mess room.

The lack of funding has indeed reduced the aspect of architectural innovation in the design. Generous spaces should have been given to staff members with their own office space. Currently, there are very few office spaces dedicated to the staff.



5.3 The Sugar Milling Research Institute, Durban- South Africa, 1950

5.3.2 An introduction to the Project

The SMRI was founded in 1950 as a joint venture involving Natal Sugar Millers, The CSIR and the University. There was a need for the centralisation of research as a means of promoting an efficient and economically viable development of sugar processing techniques. The new institute would be a separate unit in the CSIR industrial research scheme. SMRI is a non- profit making liability company.

5.3.3 The Brief

It was decided that the SMRI would be placed in the heart of the sugar belt which stretches from Mpumalanga to Port Shepstone on the South Coast of KwaZulu Natal. The new building would consist of laboratories, offices, boardroom, a library/ conference room and provide training for various institutes from South Africa and other countries.

5.3.4 Design Concepts

From the building’s form and structure, it can be argued that the driving concept was the building’s norms. A simple, cost effective design was the intended design approach. It was built in the mid 1950’s when early modernism was at its peak.

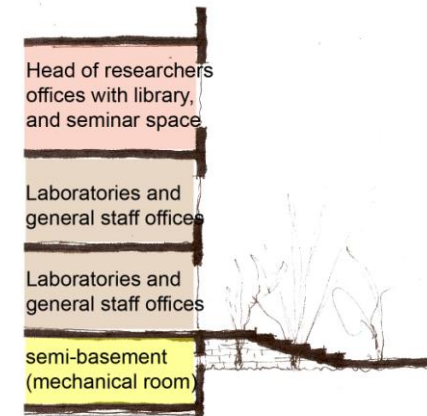
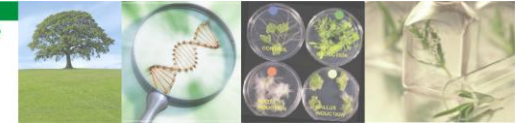


Illustration 5.3.1: Diagrammatic sketch of floor division at the SMRI (Source: Author).



Illustration 5.3.2: Main façade of SMRI (Source: Author).



5.3.5 Site Characteristics

Situated next to the University of Kwa-Zulu Natal, Howard College, the SMRI sits on a slope with dense landscaping. Its neighbours are the University Campus and an Environmental Research Facility.

5.3.6 Spatial Arrangement of the Accommodation

The three storey building consists mainly of laboratories on the ground floor with offices and other laboratories on the first floor. The library, boardroom, seminar/training room are all located on the second floor (*illustration 5.3.1*). The library is used as a multi-use space, where conferences are seldom organised, and the tea break is an everyday occurrence in such a space (*illustration 5.3.3*).

A pool table is located in the seminar/training room. This allows staff members and trainees to interact during break sessions (*illustration 5.3.4*). Smokers are given the opportunity to use a small balcony overlooking the parking (*illustration 5.3.5*).

A small exhibition space is located on the first floor. This breaks the sense of privacy and allows visitors to feel more comfortable. Another element that gives such a welcoming sense is a wall painting designed by DUT students. The staff wanted to create a joyous feeling along the staircase.

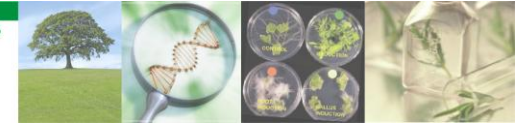
A semi- basement is used as the plant room. All the service components are also stored here. Pipes are then directed up through the floors to the required destinations.



Illustration 5.3.3: the library used as a conference space and tea-room with views to the harbour (Source: Author).



Illustration 5.3.4: the pool table in the training room (Source: Author).



5.3.7 Critical Assessments: Positive

- The site is located near the University of KwaZulu-Natal, thus creating a strong relationship within the agricultural research community.
- The use of the pool table as a significant element for social interaction among staff members and trainees.
- The creation of a pleasing environment with the corridor being used as a walk-through exhibition space and the wall painting along the staircase (*illustration 5.3.6*).
- The library being used as a meeting node at tea-break time allows staff members to have the opportunity to go through journals at that particular time.



Illustration 5.3.7: the exhibition corridor on the first floor (Source: Author).



Illustration 5.3.6: Colourful wall painting by staircase (Source: Author).

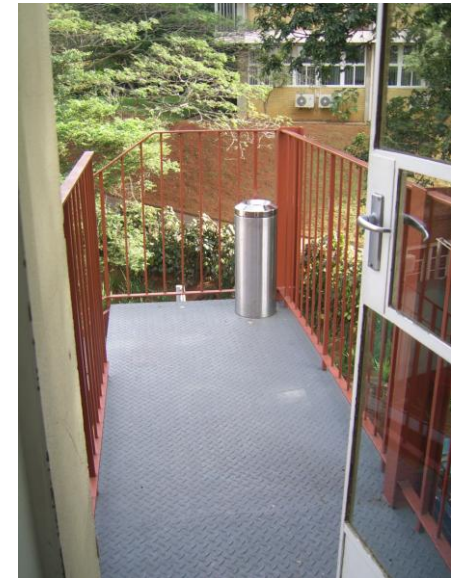
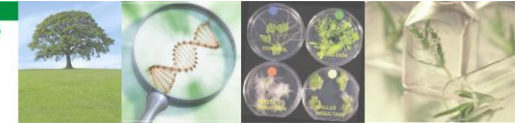


Illustration 5.3.5: Smoking deck outside training room (Source: Author).



5.3.8 Critical Assessments: Negative

- The semi-basement level used as the mechanical room is poorly maintained and ventilated (illustration 5.3.8).
- The servicing of laboratories has been inadequately planned with pipes traveling from the semi basement through the floors to specific points within the building. Such servicing strategy is not flexible, thus causing a poor servicing maintenance to the laboratories (illustration 5.3.9).
- Due to poor planning and lack of space, some offices are located within the laboratories that are artificially ventilated.
- Outdoor spaces are not fully utilised by the staff members. Courtyard spaces could have been created within the building



Illustration 5.3.8: the plant room in the semi basement with pipes going through the floor to service labs (Source: Author).



Illustration 5.3.11: Diagrammatic sketch plan of laboratory and office relationship (Source: Author).

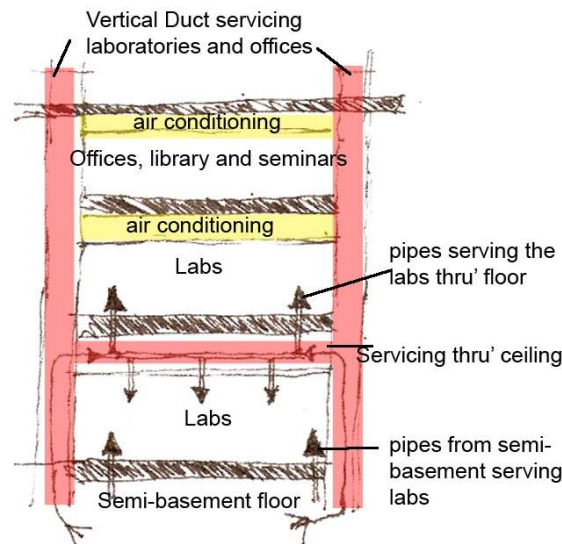
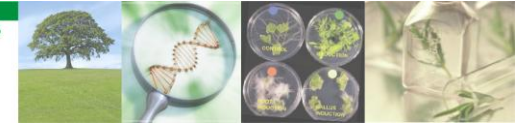


Illustration 5.3.10: Diagrammatic sketch section of servicing strategy from semi-basement floor (Source: Author).



Illustration 5.3.9: pipes popping out of the floor to service laboratory equipments (Source: Author).

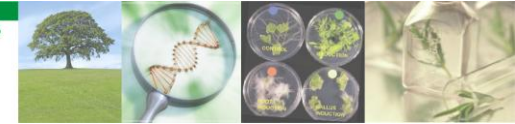


5.3.9 Conclusion from a discussion with Dr. Richard Simpson

According to Dr. Simpson, there is a need for sugar development for South Africa and biotechnology will be an important aspect for the sugar industry. It is an added value product that will benefit farmers. The SMRI was built approximately 50 years ago, and at that time, the architectural image of the building wasn't the main priority. The building was planned with a semi basement as the service floor. Such servicing strategy is not flexible for the type of experiment.

To promote interactions among the staff member, a bell rings everyday at 10:30am for tea time. "All staff would then gather in the library where tea is served," Dr. Simpson (*Personal Communication 15th July 2008*). It is a vital tool for the exchange of ideas around a cup of tea, while enjoying the view to the harbour.

The main element at the SMIRI is the social interactions among the staff. The breakaway spaces and other elements that attract staff members work efficiently.



5.4 Overall Conclusions drawn from Case Studies

After analysing the case studies, many of the findings reinforce those of the precedent studies. Thus, to avoid repetition, only relevant conclusions that haven't been mentioned before are listed below.

5.4.1 Servicing

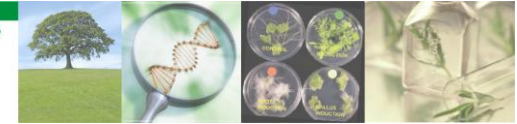
- Servicing through the ceiling is the most convenient approach which allows the laboratory space to be flexible.
- Decentralisation of services is more flexible than a centralised service plant.
- There is a need for specific service ducts and zones

5.4.2 Flexibility

- The more flexible a laboratory space is the longer the life span. This is linked with the service approach, and the use of appropriate module size and planning.

5.4.3 Planning

- The location and design of break away spaces
- The use of open plan offices that is conducive for discussions while cellularised offices are as important.



5.4.4 The Humane Environment

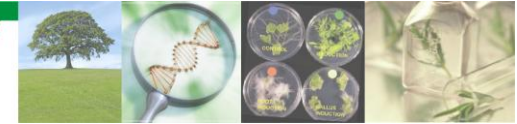
- Informal and formal spaces are important for staff member to meet
- The use of courtyard spaces improves the internal working environment within a building

5.4.5 Imagery

- Reception and waiting areas are the main public elements where creative expression of the building's vision or aim could be carried out.

5.4.6 Concluding Remarks

The social component of any research facility will benefit its users. The choice of materials is as important as it can give another meaning to the building. The servicing strategies and planning are also key elements for such a functional building.



Chapter 6- Formulation of the Design Brief

6.1 Introduction

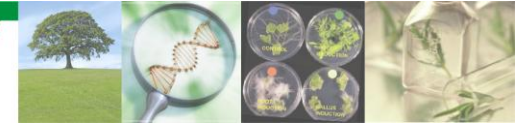
From the precedent and case studies analysed, and the interviews carried out the designer is able to formulate a design brief which is structured in two major sections: Brief Formulation and the Brief Derivation. The outcome of this chapter will then be a guideline for the design of the new facility.

6.2 Brief Formulation

The formulation of the brief is an overview of the general aspects that should be considered in the design of the new institute. These aspects are:

6.2.1 Client and Funding

The client is the Government in the form of the Ministry of Agriculture, Food Technology and Natural Resources. The client is aware that agriculture in Mauritius has remained mostly traditional and has not kept pace with the sophistication and modernisation that has taken place in other sectors of the economy. The long- term vision is to make Mauritius assume the role of a service and know-how disseminator in biotechnological applications to agriculture at the regional level and eventually emerge as a regional hub.



6.2.3 Users

The building is not for the general public. Its users will be researchers, support staff and the administration personnel. A total of 90-100 staff members are expected to use the facility.

6.2.4 Site Requirements

The proposed facility would be more convenient if its located by other related research facility. In the Mauritian context, the site would be preferably near the University of Mauritius, in Reduit which has an Agricultural department. Other requirements are that the site's soil condition must be fertile so that an agricultural test field can be set for experiments.

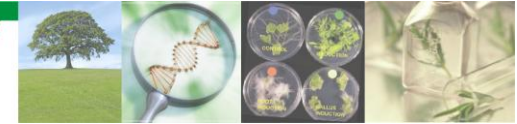
6.2.5 Client Objectives

The objectives are:

- To make major contributions to the agricultural sector
- To conduct research appropriate to the needs of the agricultural community
- To provide a world class service through qualified professionals and infrastructure

6.2.6 Design Objectives

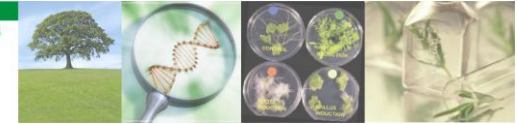
The main objective is to create a conducive working environment for the users. The functionality of the building is equally important as such building type requires flexible laboratory spaces and services.



6.3 The Derived Brief

The principal aim is to create a humane environment for the staff, keeping in mind the planning and functional part of other spatial elements within the building. The spaces required for such facility are

- Laboratories- Flexible laboratory spaces that would include open and closed laboratories
- Offices for researchers- The provision of individual office for senior staffs and open plan offices for those involved in team work projects.
- Administration/ Management Office- Such space does not have any relation with the laboratory space. Administrative works for the institute will be carried out.
- Social utilities such as library, seminar rooms and restaurant.
- Parking- In general, Mauritius has excellent public transport facilities. The parking requirement will depend on the accessibility of the public transport to the chosen site. However, an adequate amount of parking should be provided. The SABS code of practice will then be used as a reference. Usually, the ratio of parking is calculated according to the total area of the entire building; however, the mechanical room and laboratory spaces should be excluded. The former being an unoccupied space and the latter being a duplication of occupation with the research office spaces.



Chapter 7- Technical and Environmental Criteria in Laboratory Buildings

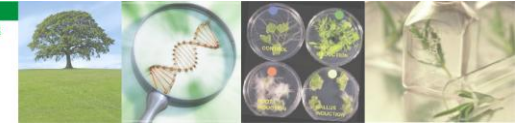
7.1 Introduction

The new Botanical Biotechnology Institute will consist of highly specialised technical and environmental criteria. Listed below are important criteria to be dealt with:

- General Planning
- Structure
- Servicing
- Safety
- Social Interaction
- Illumination
- Finishes
- Storage
- Other general aspects

7.2 General Planning

Internal organisation in a laboratory building comprises of six major patterns of special definition: Circulation of people and materials, laboratory module, distribution of mechanical equipment and service, structural system, site regulation and building enclosure (Diberardinis 1993: 29). However, an



in-depth analysis will be carried out on the first four patterns. The others don't form part of the analytical criteria that is being researched for in this chapter.

1. Circulation of people and materials

Health and safety issues of circulation are concerned with access to the building and its internal parts by its occupants but also by emergency personnel.

2. Laboratory Module

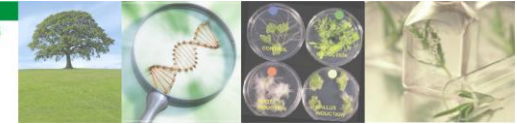
The formulation of the internal organisation of the laboratory building begins with calculating the dimensions of the laboratory module.

3. Distribution of mechanical equipment and service

The planning of ventilation air, mechanical equipment, and piped utilities is important. A great amount of energy is required by laboratory buildings to supply conditioned air to a comfortable temperature, and exhaust ventilation air. The use of vertical ducts is an efficient design approach for exhaust systems. Vertical shafts from floor to floor and through the entire building to exhaust fans and equipment on the roof is necessary for such facility.

4. Structural System

It is preferable to have as much space as possible above the finished laboratory building ceilings to use for the various ducting elements. Deep solid beams reduce unobstructed



clearance. Generous floor- to- floor heights simplify mechanical systems installation, reduce cost and allow greater opportunity for horizontal distribution.

A minimum of 2.7m from the floor to the underside of the ceiling is appropriate at a human scale. An additional 1m to 1.5m may be required for structural, mechanical and electrical systems (Gould 1986: 62).

7.2.1 The humane element in laboratory design.

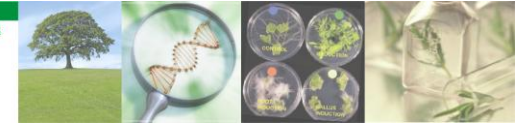
The patterns given above involve constraints on design where regulations cannot be bent. In the new age, a laboratory that is safe, cost-effective, comfortable, energy efficient and functional is not necessarily a place that scientists and skilled technical people would consider conducive to creative work. A humane environment inside is the new challenge that architects are facing.

People engaged in research usually need an environment that can allow both intense concentration and interaction with others. Therefore, proper attention should be given to ergonomics, colours, lighting, views, acoustics, temperature and humidity in laboratory design. A sense of unity and human scale should be present. Other aspects suggested by Gould P (1986: 65) include:

- Exploitation of views to any natural features.
- Penetration of natural light into spaces.
- Providing outdoor amenities such as recreational areas and terraces.
- Providing adequate ancillary facilities such as library, cafeteria and lounges.
- Giving the opportunity for users to express their preferences within the work environment.



Illustration 7.1 A dramatic skylight entry space as a focus for scientists (Braybrooke 1986: 151)



7.2.2 Site Planning

The planning should cater for vehicular access and delivery of laboratory supplies. The location of green-houses should be close to the laboratories, facilitating the transportation of specimens.

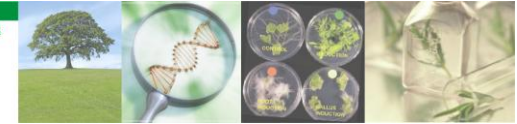
The visitor's entrance should be noticeable and clearly signposted from the outside. This avoids visitors from walking around the site and allows unauthorised visitors to be noticeable. (Griffin 2000: 27)

The site plan should be simple, ordered and as regular as possible. An L- Shape plan is the wrong initial approach to the design. This produces confusion at the junction. Accessibility to a separate building is not easy but it can be successful if it is a separate laboratory function. (Griffin 2000: 27)

7.2.3 Building Design

A one story laboratory facility allows for maximum flexibility in the rearrangement of departments, level transport of chemicals, glassware and other supplies on trolleys and staff convenience. It is more complicated to achieve such flexibility with multi- storied building. Vertical ducts should be used in such cases. However, these should be fire rated enclosures to avoid the spreading of fire. In multi- story laboratory buildings, the transportation of flammable liquids, laboratory wastes, bulky stores and heavy equipment has to be through proper lifts (Griffin 2000: 28) and can only be used for transportation purposes and not vertical movement of visitors. A separate lift is required for such process.

A multi story laboratory building requires structural columns. A clear rectangular laboratory floor space is suitable to allow furniture modules to fit perfectly. (Griffin 2000: 30)



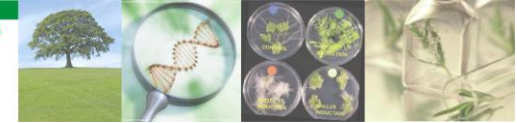
7.2.4 Work Spaces

Some areas will be an office for an individual but others will be larger, accommodating a greater number of staff performing various duties. (Griffin 2000:11).

A fully enclosed private office is usually determined by an individual's rank in an organisation.

According to Griffin, there are three types of approaches when locating staff members (Griffin 2000:6):

1. Adjacent to a laboratory workbench, at the window end of the bench:
This idea is mostly favoured by a staff member who is working on an individual project and who needs to keep an eye on his/her work.
2. Within the laboratory space but not adjacent but partitioned:
Staffs and management departments favours this layout where the staff are close enough to their work and the management feel safer if write-up time is not spent within the relatively hazardous laboratory environment.
3. Not within the laboratory space but separated by a dividing corridor:
It is the safest option and the energy efficient. The laboratory environment, with controlled temperature, humidity and clean air requirements can only be achieved with high energy consumption; whereas the office environmental requirements can be achieved with relatively low energy consumption.



7.2.5 Laboratory types

There are an increasing number of research institutions emphasising on “open” laboratory to support team-based. The old fashioned approach was the “closed” laboratory.

According to Watch, the concept of the “closed” laboratory was based on accommodating the individual principle investigator. Specific research type would be conducted in such a laboratory with specific equipment (2007: n.p).

In “open” laboratories, researchers share the same space and equipment, bench space and support staff. It also gears up for a better communication between scientists and makes the laboratories more easily adaptable for future needs (Watch 2007: n.p).

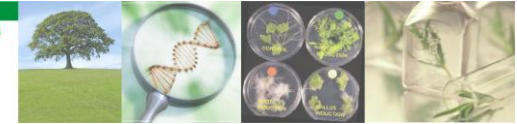
According to Diberardinis (1993:15), there are two primary factors that distinguish area standards among the experimental activities that are carried out by researchers. These are:

- The Laboratory- *“Laboratory is a category of net assignable area, in which diverse mechanical services and special supply and exhaust ventilation devices are available. Laboratories are often modular, that is, designed on a standardised room size or a precise multiple of that,”* Diberardinis L (1993: 16)
- Laboratory supports- *“Laboratory support area is a category of net assignable area that contains the same services and ventilation as the laboratory area but may or may not conform to the same modular laboratory configuration... Lab support services may be assigned to a department, but they function as a specialised resource by researchers through the building,”* Diberardinis L (1993: 16)

Furthermore, research facilities typically include both wet laboratory and dry laboratory. The former generally have sinks and piped gases with fume cupboards and chemical- resistant countertops are



Illustration 7.2 A typical “open” lab (Braybrooke 1986: 109).



required with 100% outside air supplied to it. Compared to wet laboratories, dry laboratories can be supplied with recirculated air. They are computer intensive with electrical and data wiring requirements. Their casework is mobile. A key difference is the substantial need for cooling in dry laboratories because of the heat generated by the equipment (Watch 2007: n.p).

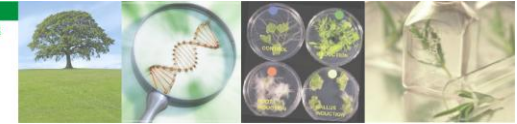
7.2.6 Environmental design

Griffin argues that the energy conservation approaches from the design aspect are mainly to do with orientation and the outer skin of the building (2000: 71). He suggests: "*The architect's role in energy conservation is mainly in the orientation of the building to expose the minimum wall area to solar energy, to use indirect natural sunlight where possible,... and to design the wall and roof fabric of the building to insulate heat exchange from outside to inside and in reverse, depending on the climatic conditions.*" (Griffin 2000: 27).

7.3 Structure

From the 'Building design' section above, it was suggested that a clear rectangular laboratory floor space is suitable to allow furniture modules to fit perfectly. (Griffin 2000:30). In so doing, a grid configuration of three metres is set according to the workbenches. The three metre grid can be divided into a 1.5m module giving the size of a double stack workbench. This allows a simple and clean system of placing columns. Flexibility of space and fittings through the laboratory space is not compromised.

The width of the central corridor should be at least 1500mm. Temptations to place objects and equipment in such space might occur if it is wider. This might cause obstruction. Obstruction of any kind



should be avoided through the corridor, for rapid exit in case of fire. The door openings into the corridors should be recessed (Griffin 2000:33).

7.4 Servicing

7.4.1 Description

Mechanical consultants performing the design services installation should have extensive and recent experience in laboratory buildings. Such facilities are constantly changing and are increasingly developing towards mechanisation. The use of various computers, data and telephone requirements is also increasing (Griffin 2000:45). This might affect the architect's decision on an architectural point of view. It is therefore required that the architect is involved in the process as the building design affects the services and vice versa.

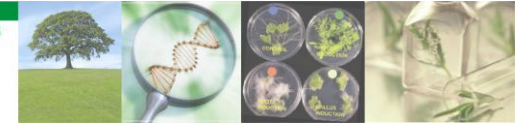
According to Griffin (2000:85), the services component significantly affects the overall cost in laboratory designs- far more than the building fabric and structure. He suggest that building services, including hydraulics, air conditioning, electrical and fire detection components can amount to 48% of the total cost (2000:85).

The factors contributing to such energy demands are:

- Research facilities contain large numbers of exhaust devices.

- There is extensive use of heat generating equipment

- Backup systems and uninterrupted power supply is required.



7.4.2 Types of service distribution

Architecturally, the manner in which services are brought to the laboratories is of major importance. An analysis of a number of related considerations, including the desired office layout and laboratory relationship, the degree of flexibility and building heights should be thought through before choosing the service type (Gould 1986:56).

There are four major types of service distributions to laboratories (Loring 1986:69):

- Continuous End- Wall Service Corridors
- Vertical Distribution
- Horizontal Distribution
- Interstitial Floors

Continuous End- Wall Service Corridors

With this service type, the mechanical and electrical services are distributed horizontally along the entire service core wall. These services are supply from main vertical service feeds that run along the corridor. The advantages of such service types are (Loring 1986:69):

- Maximising the flexibility component.
- The ease of maintenance
- The ability to make service modifications and rearrangements without affecting the work in the laboratory.
- Reduces the floor- to- floor heights.

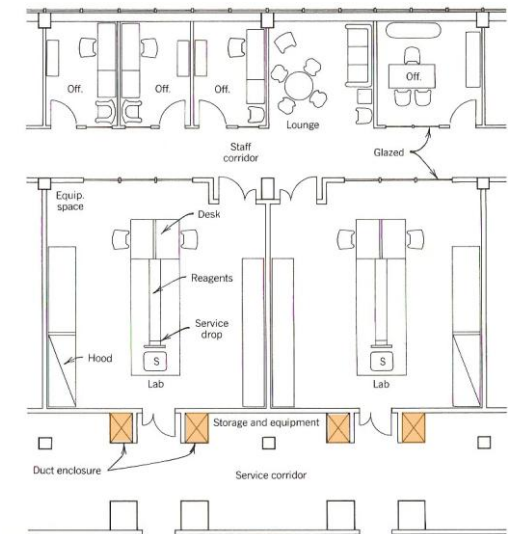
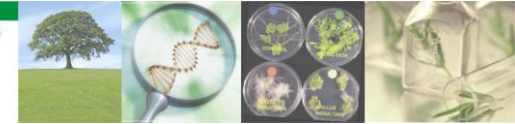


Illustration 7.3 A partial plan of a laboratory using the continuous end wall service corridor system (Gould 1986: 63).



Vertical Distribution

This system, by means of a series of vertical utility zones, supplies the required services into each laboratory through horizontal run-outs from the vertical risers to the remote equipment are required. These run either above or below the floor slab. The primary advantages of such a system are that (Loring 1986:69):

- The initial cost of installation is less
- It requires a minimum of floor to floor heights.

However, the disadvantages of the system are:

- It is not as flexible
- The cost maintenance and modification is high
- Vertical service ducts have in the past contributed to the spread of fire (Griffin 2000:28).

Horizontal Distribution

This method is characterised with the routing of mechanical, electrical, plumbing, and gas services for a series of laboratories on a specific floor. The utilities can be grouped and run at the ceiling of a double loaded service corridor. Each laboratory taps off the services that run through the corridor ceiling (Loring 1986:70).

The advantages of this system are:

- It is flexible and laboratories can be rearranged or expanded in the future with minimum of time lost, cost and disruption.

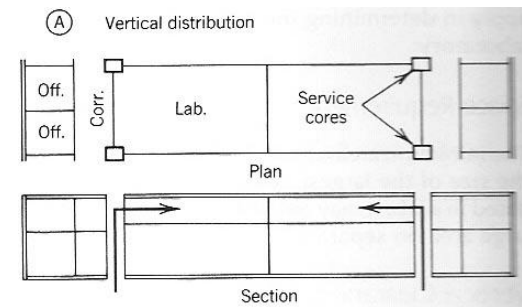


Illustration 7.4 Vertical distribution along the corridors surrounding the lab space (Gould 1986: 56).

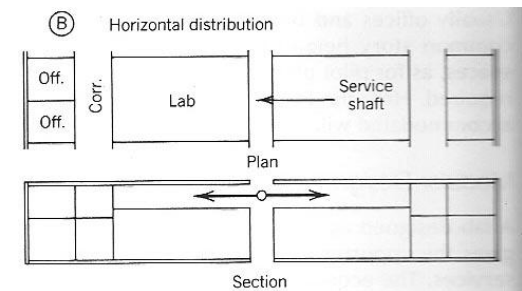
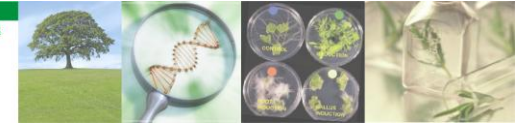


Illustration 7.5: Horizontal Distribution above the corridor to the lab spaces (Gould 1986:56)



- By grouping the horizontal distribution, safety and energy consumption can be controlled.

The disadvantages of using this system are:

- The initial high cost of mechanical and electrical systems.
- It requires a higher floor to floor height.

Interstitial Floors

This term describes the organisation of services in which the laboratory floors are alternated with floors containing utility services installed on a modular basis. If planned properly, the advantages of this approach are (Loring 1986:70):

- High flexibility
- Ease of maintenance
- The ability to make service modifications and rearrangements without affecting the operation of other laboratories.

The disadvantages of using this method are:

- A high increase in cost

7.4.3 Electricity Supply

According to Loring (1986:73), approximately 80% of the laboratory environment can be serviced by a 220V system. A dedicated distribution board should be located outside of the laboratory space. A

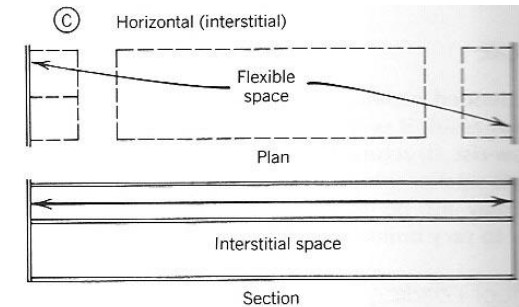
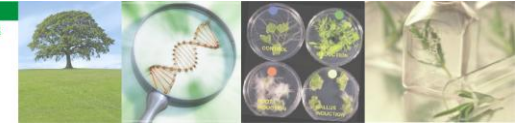


Illustration 7.6: Interstitial distribution above lab space requiring a bigger volumetric space (Gould 1986: 56).

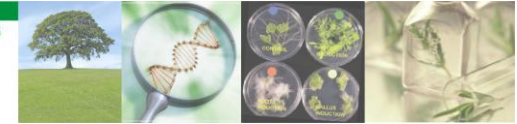


backup generator system should be included as laboratory environments cannot tolerate interruption in power. The use of steel cable trays instead of aluminium causes less electronic interference (Loring 1986:74).

7.4.4 Water Supply

Water supply is another component in service utilities. There are three types of water supply in a laboratory building (Griffin 2000:77):

- Portable Water- This consists of cold water, hot water of various temperatures and controlled temperature water (Loring 1986:89). It is used for public amenities, safety equipment and fire hose reels. The hot water is usually generated from solar heat pumps or direct solar boosted electric units. It is also supplied to facilities for the handicapped and in ablution areas. To minimise burns from hot water, it is discharged at 35°C in such facilities (Griffin 2000:77). Extreme care should be taken to protect the potable water supply from contamination.
- Non- Potable Water- Such system consist of cold water and hot water to the laboratory fixtures at 60°C (Griffin 2000:77; Loring 1986:89).
- Analytical Grade Water-this consists of cold water reticulated to each laboratory for sensitive experiments. This system is a continuous loop supply to reduce the risk of contamination (Griffin 2000:77).



Research facilities cannot stand excessive water pressure fluctuations. When such laboratories are supplied from a street pressure system where fluctuations occur, a pressure reducer should be provided on the branch lines (Loring 1986:89).

7.4.5 Gas Supply

Gases are used for a wide variety of applications in laboratories. The sources of these varieties can be broken into:

1. Liquefied gas
2. Compressed gas
3. Public utility

Flammable gases running within a laboratory building must be enclosed within another pipe which should be vented to the atmosphere.

7.4.6 Fume Cupboards

Fume cupboards are used when flammable liquids, gases, and other agents that generate fumes are involved in the experiments. It is one of the highest fire risk elements in a laboratory. These should not be located on the fire escape route and should be furthest from exits. The perimeter window wall is the best location. Such a location will allow the exhaust ducts to be external, moving vertically up the roof (Griffin 2000:50).

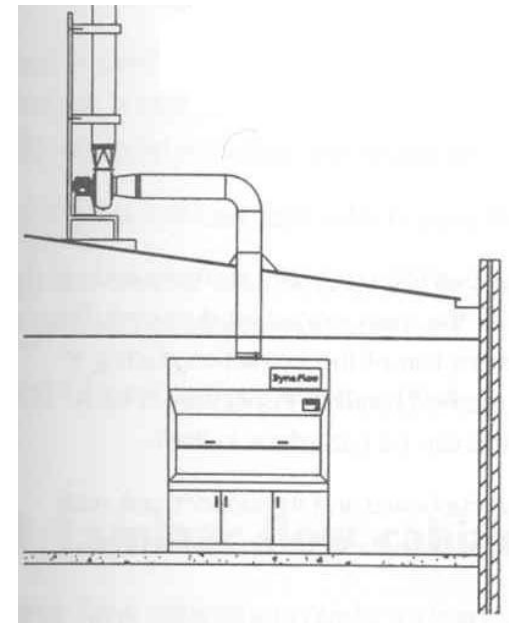
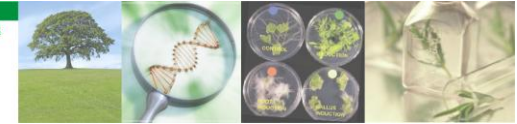


Illustration 7.7: Fume cupboards with provision of air extraction to the roof (Griffin 2000: 51).



Fume cupboards can promote energy conservation through the building. A device controlling the velocity of the air flow across the sash at all sash positions should be used.

7.3.7 Biological Safety Cabinets

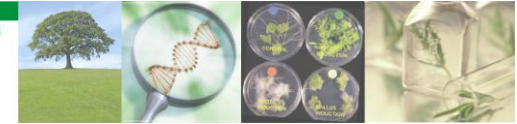
A biological safety cabinet is used to contain material as living micro-organisms and protect the laboratory user from any exposure to bacteria produced from handling the material. Such a cabinet is equipped with fans that pass recycled air through filters. It is important that the biological safety cabinets are draught free locations (Griffin 2000: 53).

The cabinet is maintained under negative air pressure so that air always stays inside it and doesn't dissipate throughout the laboratory (Diberardinis 1993: 446).

Biological safety cabinets are used for working with cell and tissue cultures and parenteral drugs. The object under experiment should be maintained in a sterile environment and the operator must be protected from toxic chemicals and infective biological agents. Therefore, the use of negative pressure improves such conditions (Diberardinis 1993:107).

7.3.8 Laboratory Waste

Wastes from laboratories usually include liquid waste from sinks and solid and gas wastes from experiments. Maintenance of waste from laboratories is the most important responsibility of the laboratory staff (Griffin 2000: 67).



Liquid Waste

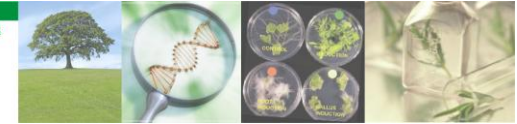
The piping materials used in liquid waste systems include high silicon iron, borosilicate glass and plastics. The neutralisation must be done through chemical reaction. Wastes are normally discharged to sumps filled with limestone chips. These raise the PH level of the waste to make it suitable for discharge into the sanitary sewer (Loring 1986: 85). Solvent waste can be discharged into specific sinks and flow through a collection tank that is mechanically ventilated to avoid explosive conditions. It can also be placed in a solvent store for collection by a contractor (Griffin 2000: 67).

Solid Waste

Solid waste is disposed in containers in the laboratory and then removed to be stored for disposal by specialist contractors (Griffin 2000: 67). In other cases, like at the Food Technology Laboratory in Mauritius that was used as a case study (*see Chapter 5*), solid waste is put in incinerators to burn down, killing all the bacteria, and what is left can be thrown away.

Gas Waste

Gas waste should be chemically treated before being released to the atmosphere. These gases should be discharged as far as possible, away from air intakes. Usually, the gas waste is discharged upwards to the roof, by means of fans located above the roof (Loring 1986: 72).



Glass Washing and Sterilisation

Glass washing may be done inside a laboratory or in a dedicated centralised space. These however, depend on the size and types of procedures carried out in a laboratory. A large central glass washing facility usually contains equipment for washing, drying and sterilising (Gould 1986: 64).

Used glassware is collected on trolleys and directed to mechanical wash machines and autoclaves. These have special trays for laboratory glassware. A small sink might be useful for rinsing prior to placing on the trolley (Griffin 2000: 45).

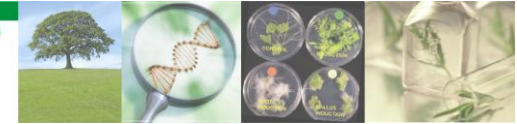
With a central facility for glass washing, there are more valuable spaces in the laboratory. The issue of water splashing onto benches and floor is then avoided (Griffin 2000: 45).

7.3.9 Laboratory Ventilation

For future change of use, the laboratory air conditioning system should be designed with flexibility. To achieve such flexibility, distributed plant should be used as oppose to central air handling systems. Chilled ceiling systems could also be considered (Griffin 2000: 74)

7.3.10 Hazardous Materials

Microbiology labs conducting procedures involving various biological processes must be designed to avoid cross- contamination between experiments and the environment and among the experiments themselves. Pressurised rooms are measures to be taken to avoid contamination and cross



contamination. Positive pressure is for clean rooms and negative for contaminated ones (Gould 1986:58).

Research involving recombinant DNA requires provisions for containment. Containment laboratories are used to develop genetic research. A high degree of isolation is required for these types of laboratories and dedicated mechanical systems with redundant features should be used (Loring 1986:70).

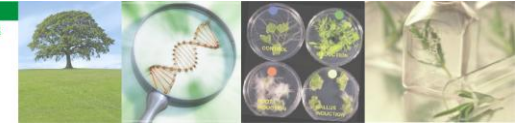
7.4.11 Fire Protection

Laboratory buildings should use a fully automatic wet pipe sprinkler system and complete fire standpipe system in case of fire. These should be hydraulically designed (Loring 1986:91).

7.5 Safety

7.5 Description

Security is an important part of design issues. A minimum of entry/exit point is usually the simple solution. Visitors are not aware of the hazards and can be a danger to themselves and to the laboratory. Staff members know the risk and follow safety procedures (Griffin 2000:16).



7.5.2 Planning

Any uninformed person can become a hazard not only to themselves but also to the laboratory itself. The laboratory environment is a high risk area and needs to be separated from the more public realm. A physical barrier with limited number of access points to the laboratory spaces is required. These access points could thus be controlled (Griffin 2000: 16). Moreover, the labs need to have fire rated isolation due to the higher fire risk that they pose (Griffin 2000: 27).

7.5.3 Safety Equipment

The type of safety equipments used in laboratory buildings is the fire extinguisher and fire hose reels. These are standard precautions in the most public/semi private spaces. On the other hand, the laboratory space which is more private requires safety showers, face and eye wash. These should be located in the laboratory space, along the main circulation walkway for easy access.

7.6 A Social Building

Modern science consists of a great deal of social activity. When supported by architecture that facilitates both structured and informal interaction science functions at a better rate (Watch 2007: n.p). Such an environment can be achieved by establishing places such as break rooms, meeting rooms and atrium spaces where people can congregate outside their labs to talk with one another. Staircases or stairs off an atrium with built-in window seats encourage people to meet and exchange ideas (Watch 2007: n.p).

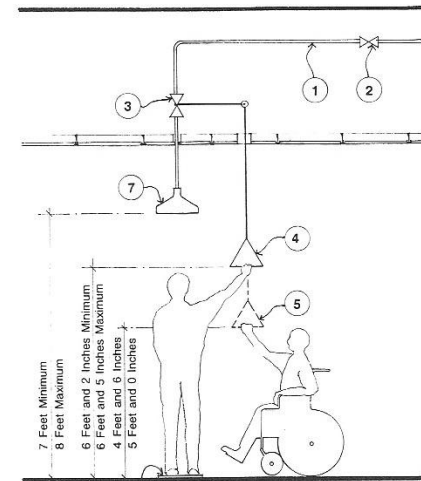
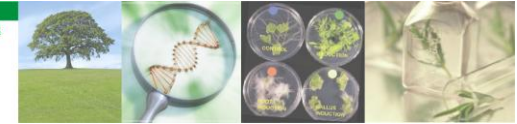


Illustration 7.8: A safety shower in case of hazardous spills on humans (Diberardinis et al. 1993: 480)



Illustration 7.9: An atrium with vertical staircase as a feature but also a place for social interaction (Braybrooke 1986: 120).



Griffin agrees, arguing that the need for laboratory planning to facilitate, encourage, professional interaction is now recognised by management as part of professional work. Ideas can spring to the mind when these informal interactions occur (2000: 3).

7.7 Illumination

7.7.1 Natural Day-lighting

It is important to provide scientists with laboratories that foster innovation and enhance performance. One way to achieve this suggests Wirdzek (2003: 1), is by designing laboratories that make good use of natural light. The use of day light not only saves energy but also helps to provide an internal working environment that motivates creativity and discovery (Wirdzek 2003: 1).



Illustration 7.10: Natural day-light into laboratory space (Wirdzek 2003: 3).

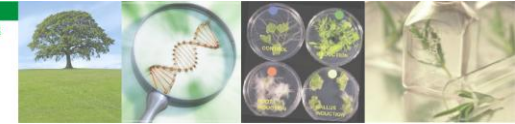
7.7.2 Artificial Lighting

A higher illumination at the workbench in laboratories is required. Usually requiring 500 lux, to conserve energy, it is best to have light coloured walls, ceilings, floors and furniture surfaces (Griffin 2000: 34). It is also recommended that there is no direct sunlight penetrating areas where the workbenches are; indirect natural day-lighting is encouraged. Overhead light fittings can be used as an extra light source and these should be perpendicular to limit shadows being cast over the work surface. For the same reason, workbenches should be perpendicular to the windows (Koenig 1985: 158).

In case of fire or other emergency, it is necessary to provide sufficient light for the occupants in the building for evacuation purposes. The lighting system for such purpose needs to be divorced from the normal electricity supply just in case the latter is inoperative (Watson 1986: 102).



Illustration 7.11: Artificial lighting fixed parallel to furniture layout (Watch 2007: n.p).



The architect should also consider illuminating the surroundings of the building. This will provide a more secure and safer environment and also enhances the appearance of the building at night (Du Plesis 2008: 98).

7.8 Finishes

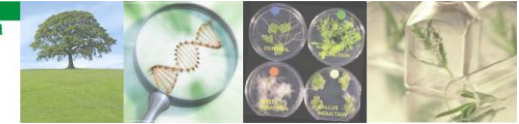
Floor coverings in laboratories should be pre-finished sheet vinyl or equivalent materials that are manufactured specifically for the laboratory use with welded joints of 150mm up the walls. Abrasive surfaced materials are not encouraged to use as they collect dirt from shoes and are difficult to clean (Griffin 2000: 34).

The floor finishes must be non-slippery, especially in wet conditions, resistant to water and chemicals, and must be sealed at the junction. Tiles and wood should be avoided (Brown 1994: 19).

The walls need to be smooth, cleanable and impervious to water and chemicals. Tiles may be used but wood is not recommended. Other recommended types are plastic panels, and sprayed or brushed paints. The use of a light or neutral colour is preferable but with non-reflective finishes avoiding interference with reading of tests. Note that a white surface finish may cause glare (Brown 1994: 19).

7.9 Storage

Traditionally, chemicals have been stored under the workbench, on shelves behind the workbench and in full-height wall cabinets. Due to the increasingly safety awareness, the storage of chemicals in the laboratory itself is being limited. A central storage facility is provided in easy reach of the scientists (Griffin 2000:13). However, due to the nature of the chemicals being used, the bulk storage of them is usually kept outside the building in case of explosion.



As storage facilities in the laboratories, mobile carts and adjustable shelving are used. The carts facilitate easier sharing of resources and can be stacked when not being used. The adjustable shelving is easily modified to provide the height and spaces required (Watch 2007: n.p).

7.10 Incubators

Incubators are used for seed germination, growth and culture experimentation. They need to have a clean air environment (Griffin 2000:45).

The walls should be insulated and a controlled temperature of 20-25C with floor- to- ceiling shelving. Fluorescent lights are used under the benches and these should be time controlled. No sinks or water supply is required. The floor is sealed to reduce dust or contamination (Jones et al. 2003: 35).

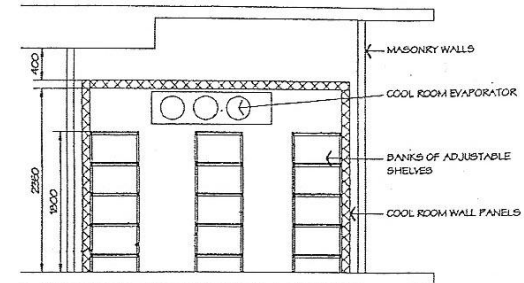


Illustration 7.12: Incubator with wall insulation (Jones 2003: 35).

7.11 Greenhouses

Greenhouses are usually separated structures away from the main building. The plants from the incubators are moved after a period of time to the greenhouses to get used to the outside environment. However, these should be protected from direct sunlight and the actual structure is surrounded with water to prevent insects and ants from penetrating the building and infecting the young plants (Dr. Dookun Saumtally: personal communication).



Illustration 7.15: Water surrounding the greenhouse to prevent any crawling insects from penetrating inside (Source: Author).

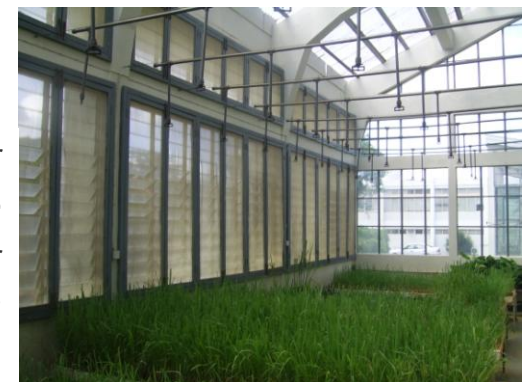
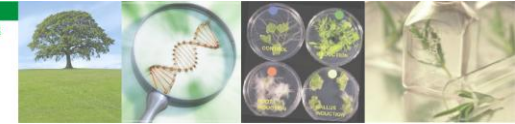


Illustration 7.14: The interior of greenhouses at the MSIRI with shower hose for irrigation purposes (Source: Author).



7.12 Other General Criteria

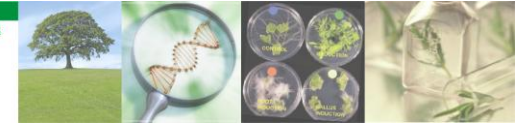
- For a better functionality and safety aspect in laboratory design, a separate lift is recommended. Damage is likely to occur if large pieces of equipment are moved within a lift. It is also used to move chemicals and specimen in and out. For the safety of the public, they are not allowed to use the same lift (Griffin 2000: 93).
- Signage is important in research facilities. These indicate potential hazards, as well as requirements to be complied with before entering the space (Du Plesis 2008: 100).
- A larger door width is required to access laboratory spaces. The recommended size is 1.5m wide, thus allowing the movement of larger equipment. One leaf for the door is usually sufficient but a second is required to allow for a 1.5m clear opening (Griffin 2000: 35, 60). If ramps are used, these should also be 1.5m wide to allow for trolley movements (Griffin 2000: 94).

7.13 Conclusions

7.13.1 Planning

Through the various researches carried out on research facilities and the understanding that such a facility requires a high cost of services, efficient planning is the key component. A rational service layout is required to provide easy functioning of the laboratory spaces, whilst considering the structural aspects of the design. These should not obstruct service supply, thus allowing a flexible servicing.

Other components are the use of natural day lighting which not only reduces the energy consumption of the facility, but also creates a more enjoyable space to work.



The choice of materials in such a humid climate will also reduce the energy consumption. Various strategies should be analysed for a better design scheme.

7.13.2 Human Interaction

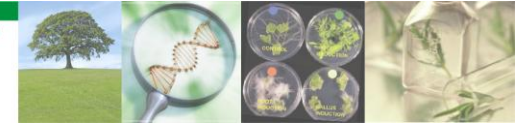
As Griffin argues, there is a great need for professional interaction between scientists (Griffin 2000: 3). Thus, the design should promote such interactions, visually and physically.

7.13.3 Flexibility

The nature of laboratories is such that they should be flexible enough to allow a change in experiment types. This will include a change in floor area required for such specific experiments and a change in service types within the laboratory spaces. Therefore, service systems must be easy to alter and a flexible module size should be used.

7.13.4 Specific Requirements

Other specific requirements for the design of a new research facility have been discussed in this chapter. These include: Servicing, safety, finishes, illumination, waste disposal and storage.



Chapter 8: Conclusions and Recommendations

8.1 Introduction

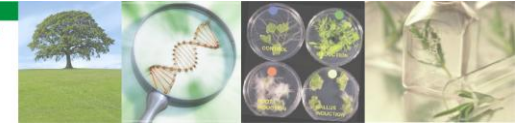
Through the research and analysis carried out in this document for the design of a new Botanical Biotechnology Institute for Mauritius, four main elements should be considered in the design of such a facility:

- The working environment
- The Service strategy
- Environmental Impact
- The practical requirements

These elements are briefly reviewed below in *section 8.2*

8.2 The Design Approach

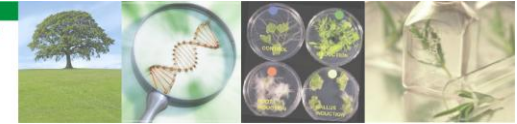
The working environment in a research institute defines the success of the building. This has been noticed at the Institute of Forestry and Nature Research in Netherland. Various researchers of different backgrounds will work in the proposed institute and formal and informal spaces dedicated for the enrichment of knowledge and the discussion of ideas are ingredients for a modern research facility. The design should be interactive, and encompasses a creative and vibrant environment. The use of natural features and architectural elements should be exploited. Traditional laboratory designs have downgraded the human aspects and working environment. Laboratory spaces in which scientists



experiment and offices are two different spaces of different functions and need to meet different requirements. Chapter 3 and Chapter 4 have illustrated the 'pros' and 'cons' of having these two different spaces and how a better working environment can be achieved.

The key to the practical success in laboratory design is its servicing strategy. Such success is defined by the flexibility and serviceability of the building. The flexibility allows a change in laboratory layout without any structure preventing this change, and the serviceability provides easy connectivity to the services needed by the researchers in the laboratory. The horizontal distribution has service lines running along the ceiling and tapped off where required. It is highly flexible and offers the lowest life cycle costs. Furthermore, the various laboratory spaces needed for the Plant Biotechnology Institute should be identified and broken into the categories as suggested by Diberardinis (Diberardinis 1993: 16). These would facilitate the flexibility and serviceability of the laboratory design.

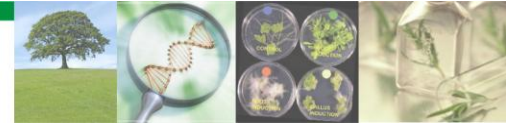
Because laboratories are higher consumers of energy and water than a typical office building, it is critical to implement strategies to reduce the impact such a facility has on the environment. Proper orientation will facilitate a reduction of energy, and the use of natural day-light in the laboratories will help significantly. It should also be noted that as the location of the proposed facility is in Mauritius, a tropical island in the Indian Ocean, the climatic condition should not be left aside. It is hot and humid, causing uncomfortable conditions. The use of material and the approach to roofing systemd would be important. Having understood the technical requirements of laboratories, direct sunlight should be avoided in laboratory spaces as this may cause an increase in the use of air-conditioning.



Practical requirements set by international standards are very specific. These should abide in the design for the new research facility.

8.3 Concluding Remarks

Research and laboratory designs have constantly being evolved. The traditional approach which was more of an office type layout has now developed to a more open and social building. The contemporary approach allows scientists to breathe and communicate more between each other. Though services and practical requirements are still among the main aspects in laboratory designs, the professional interaction is now recognised by management as part of professional work. The IBN-DLO scheme in Netherland used as a precedent study seems to be the most successful through its acknowledgement of environmental impact and creating a better working environment. Therefore, the approach to the design of a new Botanical Biotechnology Institute should indeed create a congenial working environment and allow its users to connect to nature.



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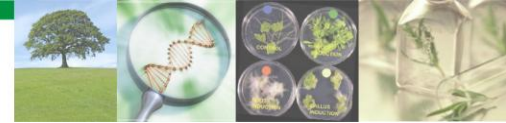
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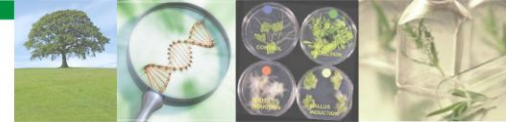
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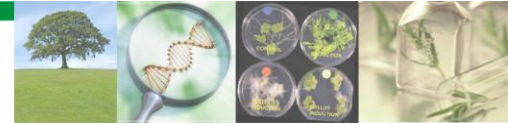
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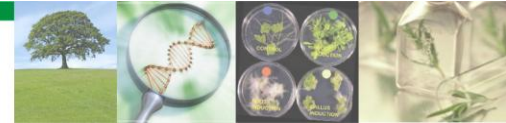
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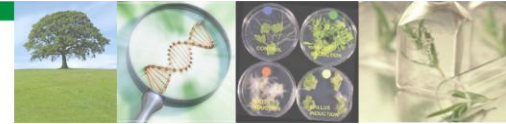
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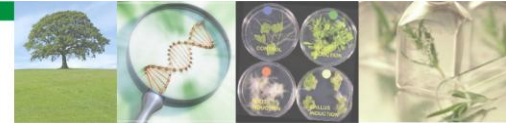
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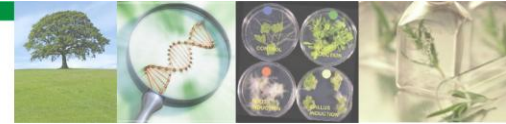
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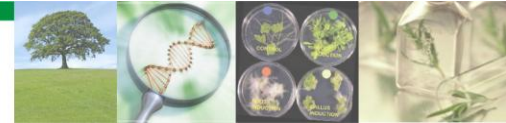
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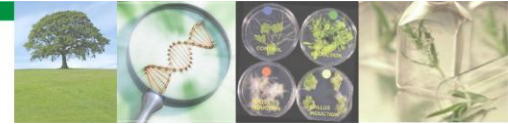
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APPENDIX A- OUTLINE OF STRUCTURED INTERVIEWS

Structured Interview: Architects

Design Approach:

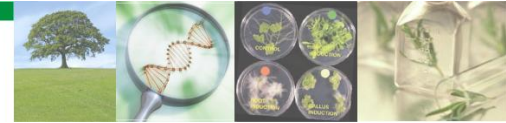
- What was the driving concept in the design of the building?
- How was the functions and space making managed?
- Were there any important criteria to the design?
- How has environmental factors such as topography, orientation, surrounding land functions, vehicle and pedestrian movement and potential impacts (such as sound, vibration and other environmental pollutants) of surrounding activities on the site been designed for?
- What was the approach in terms of security and access to the building?
- Was there any concern about the flexibility of the building?

Servicing:

- What was the approach to services and requirements of the building?
- Is there any specific reason for choosing such a service type?
- How is the long term flexibility of services addressed?

Physical components

- What was the structural approach of the design and did how did it affect the servicing?
- Was there any attempt to create a more human working environment within the facility?
- Has expansion of the building been explored into the design?
- What has been the approach to minimising environmental impact?
- Are there any strategies that have been implemented to increase the use of natural energy such as light and natural ventilation?



Structured Interview: Researchers

Biotechnology and Architecture:

- What is the importance of biotechnology research in the 21st century?
- Is there any significant architectural element informing this importance and did it change over the last few years?
- Is there any other architectural element that could be associated to such research facility?

Servicing

- What would be the best design approach to servicing a laboratory building, bearing in mind that flexibility of servicing is an important aspect of such a building?

Work Environment

- Are there any important characteristics that you value and that should exist in the building?
- Is informal meeting considered an important aspect to the work progress within a research facility?
- Are there any special humane elements within the building that you value?

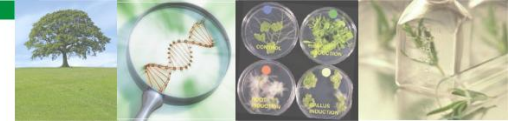
Planning

- Any comments on the accessibility to the building?
- Has the building been planned properly?
- Do you think the building was designed to carry out research or was it a structure that was renovated to suit research experiments?
- Are the overall sizes of spaces adequate?

APPENDIX B- AREA ANALYSIS

Component	Donald Danforth Plant Science Centre		IBN- DLO		NEUROSCIENCE INSTITUTE		Average	
	Sq m	%	Sq m	%	Sq m	%	Sq m	%
Offices	950	11.4	2400	36.9	1440	46	1597	26
Laboratories	1740	20.9	2000	30.8	800	25.6	1513	25.3
Laboratory Supports	300	3.6	N.a	N.a	N.a	N.a	100	1.7
Discussion spaces	100	1.2	N.a	N.a	N.a	N.a	33	0.55
Mechanical Plant Room	1000	12	N.a	N.a	250	8	417	6.9
Administration/Management	600	7.2	390	6	180	5.8	390	6.5
Lbrary	130	1.5	650	10	190	6.1	323	5.4
Central Social Space	400	4.8	260	4	67	2.1	242	4.1
Conferences/Aduitorium	600	7.2	200	3.1	200	6.4	333	5.6
Green Houses	1000	12	300	4.6	N.a	N.a	433	7.2
Growth Chambers	1500	18	300	4.6	N.a	N.a	600	10
TOTAL	8320	100	6500	100	3127	100	5981	100

The above area analysis is only used as an indication. Due to the scale of the original plans of the buildings and some spaces on the plans couldn't be determined, there might be some inaccuracy.



Design Dissertation 2009

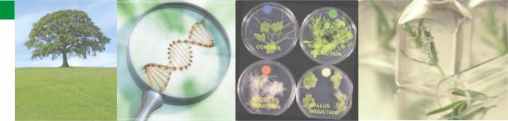
Design Report towards the design of a new Botanical Biotechnology Institute for Mauritius



Prepared by SOOBRATTEE Mohammad Afzal

Student number: 202524047





Introduction

Laboratories are highly specialized facilities. These are introverted spaces where scientists test their ideas. Such services consume a lot of energy and are fully air-conditioned. The new trend in laboratory design is to promote formal and informal interaction. Such interactions have a positive impact on individual research projects. These are now recognized by management as part of professional work.

The design of the new Botanical Biotechnology Institute sets out to create not only an environment that facilitates the users in the process of research, through social interactions; but also a service functional environment. Research has revealed that the required laboratory spaces need a clean environment, highly serviced and has numerous functional requirements. These criteria are equally important.

It is therefore established that the design should promote social interaction, and this implies that the building requires a conducive public realm. Aldo Van Eyck suggests that spaces should be anchored to the public realm by having them open onto a larger internal street, and thereby encourage the individual to interact in the public domain (Van Eyck 1999: 89).

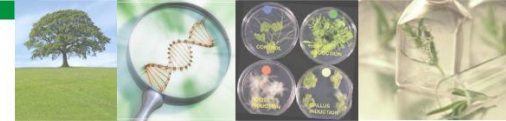
The proposed facility deals in DNA research of plants. The need to express transparency in the research being conducted will create confidence within the research community.



Illustration 1: Lounge and meeting pods at the Plant Science Centre in USA (Mackeith 2002: 158)



Illustration 2: The Peachtree Plaza Hotel in Atlanta designed by Portman (Portman 1976: 119).



Site Selection

Urban Characteristics of site

Site size

From the precedent studies and case studies analysed, it has been concluded that the new proposed botanical biotechnology institute require testing fields for the plants being examined. Therefore, a large site is required for the new facility.

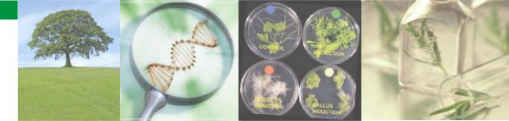
Context

According to Gould, P (1986:51) and Watch (2007: n.p), the site should be at proximity to a research university while the immediate surrounding environment should be pleasant, that is, in terms of landscaping, views, etc. Noise, dust and vibrations may be unfavorable to the building functions. The site should be easily accessible. Thus, an existing road network and public transport facility will ensure that staff members and the visitors easily access the building.

Environmental Considerations

Orientation

A site orientation that allows the building to align with the north-south axis is preferred so that sunlight can be easily controlled, creating a more comfortable environment within the building. This is however, not fundamental to the site choice.



Pollution

The institute needs to be in a quiet area with little pollution. Plants require healthy air to grow properly. However, noise levels can be controlled. This can be achieved through natural barriers such as dense vegetation and topography can help to control the noise.

Soil Condition

The site's soil need to be fertile so that plants can grow healthily. It will also allow the soil to absorb rainwater easily.

Choosing the District

Due to heavy congestion and over use of the land resources in the capital of Port Louis, the government created a new economic artery known as Eben. It lies in the District of Moka that is enriched with commercial, residential, educational facilities and small enterprises (*see Illustration 3*). The aim at Eben is to promote socio-economic development. Moka also consist of extensive agricultural lands mainly for the sugar industries.

Choosing the Precinct

Reduit is a precinct of knowledge in Moka with the University of Mauritius, educational facilities and Research & Development centres . The district is linked to residential suburbs: Beau Bassin, Rose Hill and Moka through road networking. Reduit is located next to Eben (*see illustration 4*).

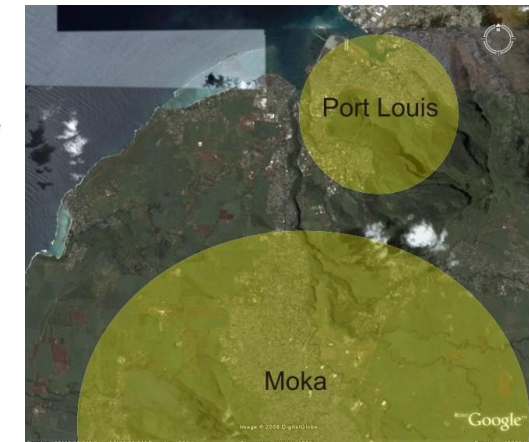
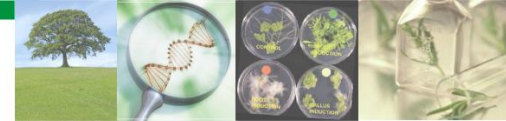


Illustration 3: Location of the capital city Port Louis in relation to Moka District (Google Earth: n.p)



Illustration 4: Location of precincts along the highway (Google Earth: n.p)



Site Options

Introduction

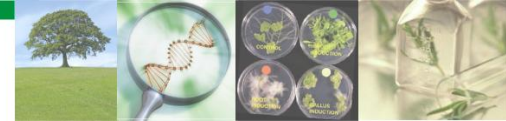
Three potential sites have been chosen for the location of the proposed Botanical Biotechnology Research Institute. Small sites were eliminated due to the requirements of the institution. The three potential sites are located in Eben and two in Reduit.

Locations

- SITE 1: The first site in Eben is an empty one on higher grounds with the Terre Rouge River adjacent to it.
- SITE 2: The second site is a deserted one which was used by the Agricultural Faculty as testing fields. It is no more of use and left abandoned.
- SITE 3: The third site is located between the UOM and MSIRI in Reduit, along a pedestrian route linking those two institutions.



Illustration 5: Site Locations in precincts (Google Earth: n.p)



Site Option 1

Introduction

Eben is a newly developed precinct. New office buildings are coming up around the site. The area of the site is 55,980 sqm. The site is along a strong axis that terminates with the cybertower.

Urban Characteristics

- The site is easily accessible through the road networking and public transport. The road network links the site to a residential precinct, Quatre Bornes and is easily accessible from the highway.
- Commercial facilities are located less than 200 metres from the site with fast food outlets and other activities.
- The University and other facilities related to agriculture are at driving range from the site.

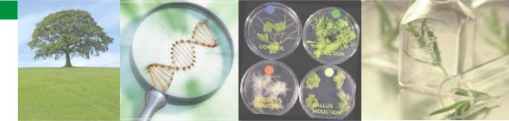
Environmental Considerations

- The site is orientated on a north-south axis, facilitating sunlight control through the building.
- It is relatively quiet around the site. The major noise that can be predicted with time is from the main road along the site.
- The precinct was an old agricultural land that is now converted to an urban developing area. The soil condition is healthy enough for cultivating crops.



Illustration 6: Site Option 1

(Google Earth: n.p)



Site Option 2

Introduction

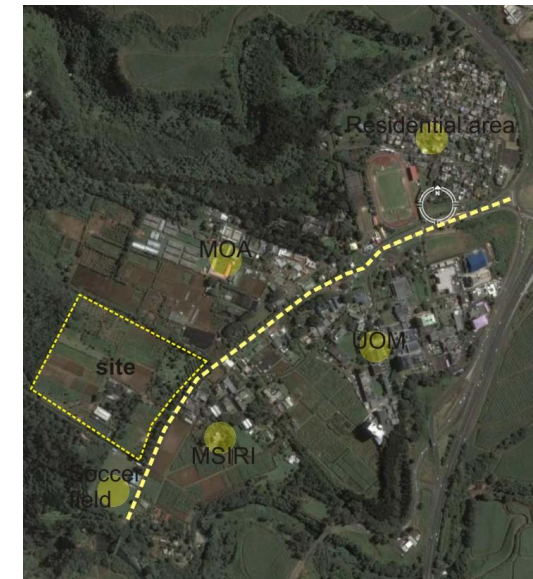
The site is along the Reduit Road which is linked to the University. It was used by the Agricultural Faculty, but is now a neglected site. The area is 52, 700sqm.

Urban Characteristics

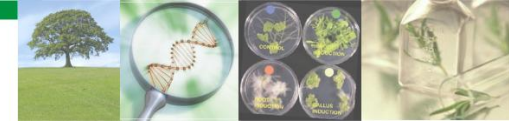
- The site is large enough to accommodate the Plant Biotechnology Institute.
- The road never links up to Eben. It is a dead-end.
- The site is not accessible to the public transport.
- Its neighbours are a soccer field, the MOA and the MSIRI, and near the University of Mauritius.

Environmental Considerations

- The site is orientated on a South East- North West axis.
- It is a very quiet road.
- It has healthy soil as it was used by the Agricultural Faculty before.



*Illustration 7: Location of Site 2
(Google Earth: n.p)*



Site Option 3

Introduction

The site is of 33, 300 sqm and is located in Reduit, between the MSIRI and UMO. It is currently part of the MSIRI boundary but is not being used extensively.

Urban Characteristics

- The site is large enough to accommodate the Plant Biotechnology Institute.
- It is easily accessible through the existing road networks and public transport.
- It is at walking distance from UOM, MOA, the MSIRI
- It fits in an urban context
- There is an existing pedestrian route that runs along the site, linking the MSIRI to UOM.

Environmental Considerations

- The site is orientated on a North- West/ South East axis
- The roads framing the site are relatively quiet
- It is located in a dense vegetation area, thus reducing the air pollution level
- The soil is healthy and in good condition to be used as testing fields.

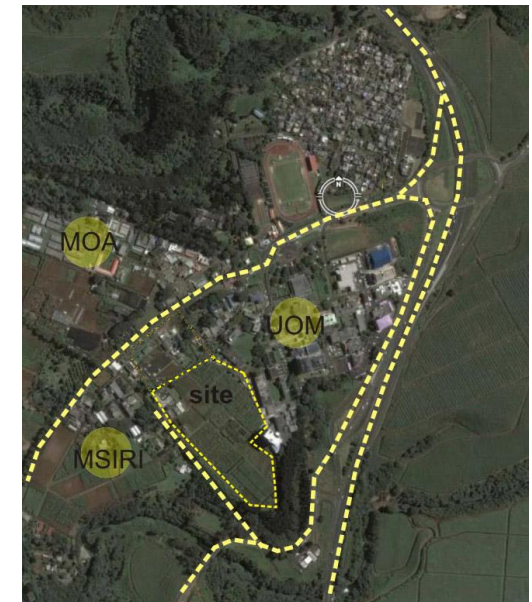
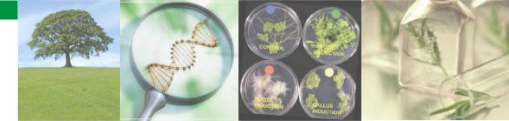


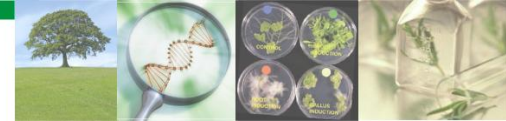
Illustration 8: Location of site 3

(Google Earth: n.p)



After a process of ranking, Site 3 was selected for the location of the Plant Biotechnology Research Institute

	SITE 1	SITE 2	SITE 3
ACADEMIC LINKAGES	None RANKING 4	Close proximity RANKING 2	Very close RANKING 1
LAND AVAILABILITY	Ample RANKING 1	Ample RANKING 1	Ample RANKING 1
EXISTING RESEARCH FACILITIES	None RANKING 4	Close proximity RANKING 2	Very close RANKING 1
ACCESSIBILITY	Easily accessible from the highway RANKING 3	Not accessible to all types of transport facilities RANKING 4	Accessible to all RANKING 1
ENVIRONMENTAL CONSIDERATION	Will get noisy in time RANKING 4	Quiet RANKING 1	Quiet RANKING 1
OVERALL RANKING	3	2	1



Site Analysis

The site is prominent and would offer the new Plant Biotechnology Institute fantastic exposure. It is next to the MOA, MSIRI, UOM and the Food Technology Lab.

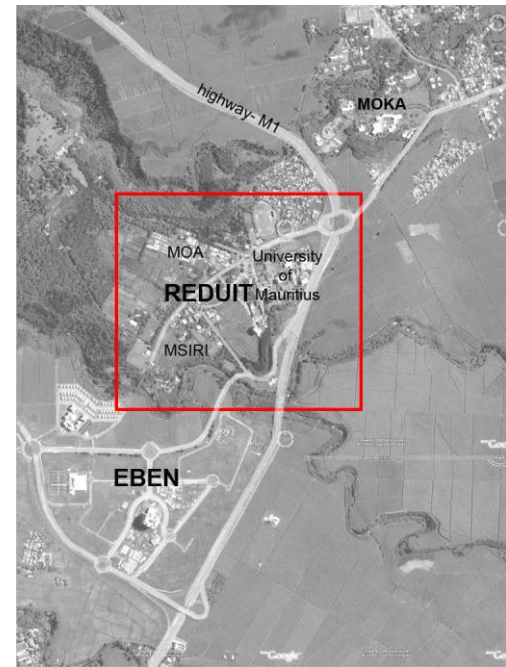
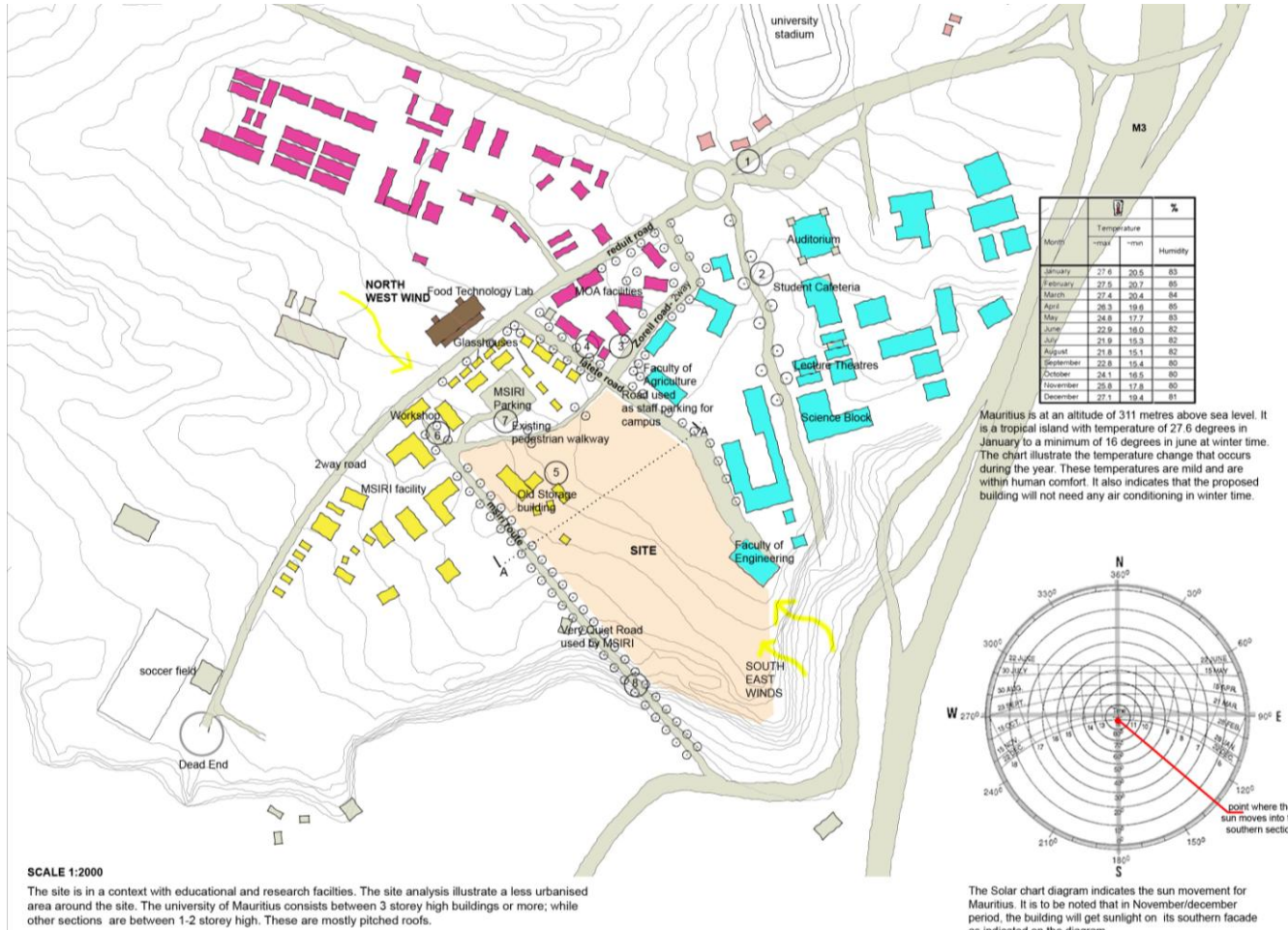
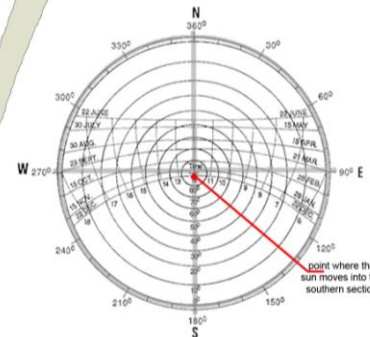
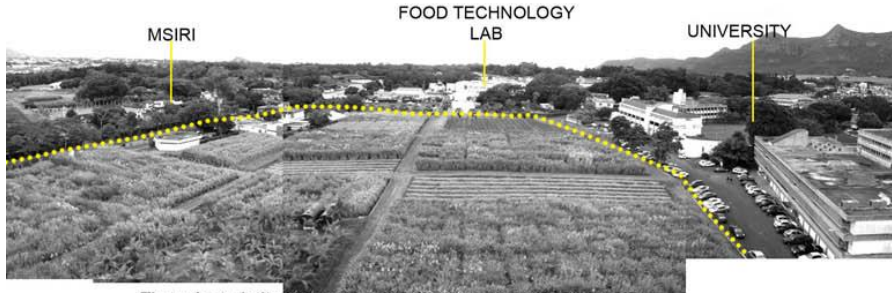


Illustration 9: Aerial view Reduit indicating site and major routes (Google Earth: n.p)



The Solar chart diagram indicates the sun movement for Mauritius. It is to be noted that in November/December period, the building will get sunlight on its southern facade as indicated on the diagram.

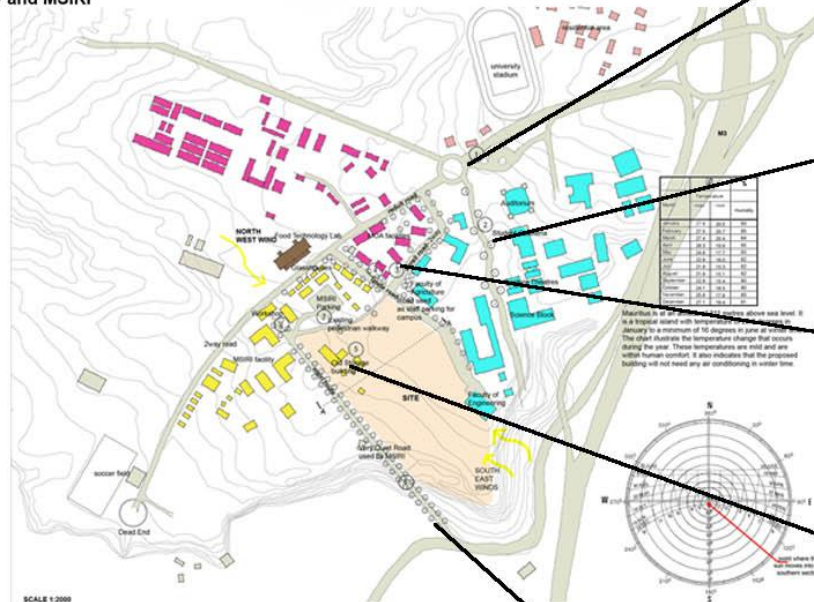
Illustration 10: Site map indicating noise source and vehicular routes with a pedestrian walkway along the site. It should be noted that in December, the sun moves into the southern hemisphere, as noted from the solar chart diagram



The selected site in the context with the university and MSIRI

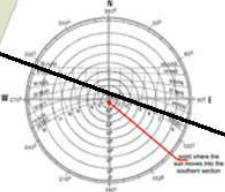
Illustration 11: Arial view of site and pictures of the surrounding context.

It was noted that staff members from the various research facilities had no place to spend their lunch and tea break. This indicates that there is a lack of open space with sufficient amenities that they can use during their break



SCALE 1:2000
The site is in a context with educational and research facilities. The site analysis illustrates a less urbanised area around the site. The University of Mauritius consists between 3 storey high buildings or more, while other sections are between 1-2 storey high. These are mostly pitched roofs.

Mauritius is at an altitude with temperature above sea level. It is a tropical island with temperature above sea level. In January to a minimum of 10 degrees in June at winter. The chart illustrates the temperature change that occurs during the year. These temperatures are mild and are within human comfort. It also indicates that the proposed building will not need any air conditioning in winter time.



The Solar chart diagram indicates the sun movement for Mauritius. It is to be noted that in November/December period, the building will get sunlight on its southern facade as indicated on the diagram.



1. Bus stop on Reduit Road



2. The main entry to University of Mauritius



3. Two storey buildings for the MOA on Zoreil Road



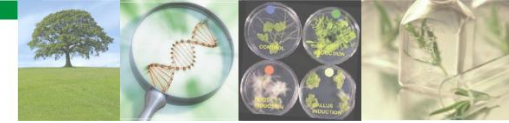
5. Old facilities for the MSIRI



Walkway linking the university to the MSIRI



8. Indigenous trees lying on both side of the entrance road to MSIRI



Urban Intervention

As noted from the site analysis, there was a need for an urban intervention. Such interventions include the proposed future extension of the MSIRI, proposing a landscaped walkway with light poles, drinking fountains, benches and dustbins and shading along the walkway. The walkway links to a restaurant, allowing the opportunity for staff members from the various research complexes to make use of this facility, thus assisting in multi-disciplinary interactions.

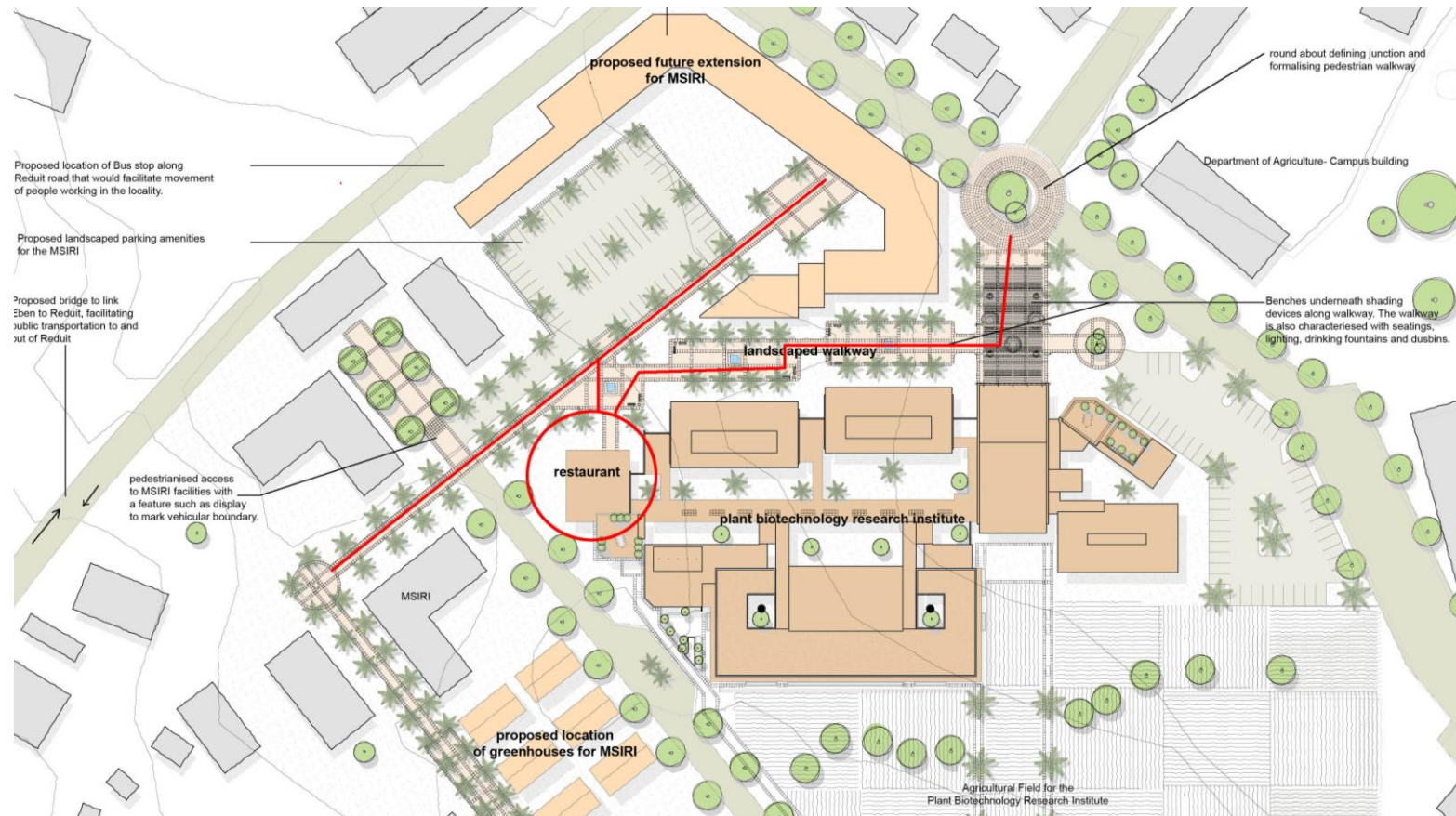
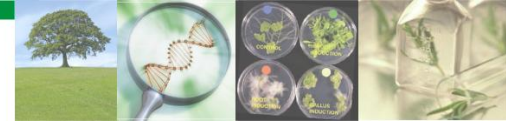


Illustration 12: A site map illustrating the various urban interventions. These includes the landscaped walkway, the proposed future extension of the MSIRI and the relocation of greenhouses



Function of the Building

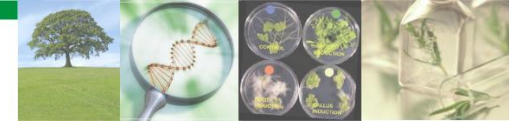
The aim of the researchers is to provide the agricultural industry with suitable and adaptable variety of plant specimen while combining appropriate technology. Such technology is the application of biotechnology, a result of combining biological science with technology.

Client and Brief

The client is the Government in the form of the Ministry of Agriculture, Food Technology and Natural Resources. The client is aware that agriculture in Mauritius has remained mostly traditional and has not kept pace with the sophistication and modernisation that has taken place in other sectors of the economy. The client therefore, came up with the proposal for the setting up of a Plant Biotechnology Institute. Their objectives are:

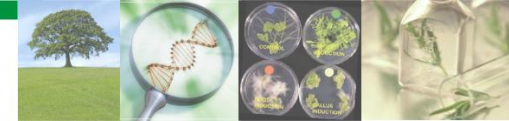
- To make major contributions to the agricultural sector
- To conduct research appropriate to the needs of the agricultural community
- To provide a world class service through qualified professionals and infrastructure

The proposed institute will therefore consist of laboratories and lab supports; offices for researchers and administrative department, seminar rooms, a library and a restaurant. The users of the building will be the general staff, visiting professionals will be expected to collaborate with the staff or attend occasional seminars. Post-graduate student will be also expected to attend occasional seminars or consult the staff members. A total of 90-100 staff members are expected to use the facility.

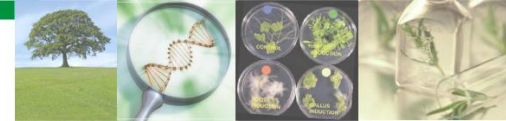


Schedule of Accommodation- The following spaces for the Plant Biotechnology Institute have been determined through consultations with the client and from conclusions drawn from precedents and case studies:

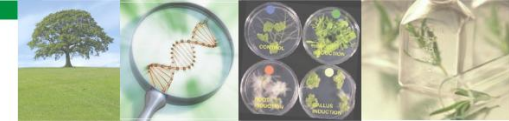
COMPONENT	SPACE	QUANTITY	SIZE	TOTAL AREA	DESCRIPTION
Laboratories					
	Infectious Organism	1	120	120	The study of infected specimens
	Plant Diagnosis	1	70	70	Plant identification unit
	Entomology	1	120	120	The branch of science that deals with insects that cause disease or that serve as vectors of organisms that cause disease in
	Plant Microbiology	1	70	70	The study of organisms such as bacteria, viruses and yeasts
	Plant Pathology	1	120	120	The study of disease in plants; it is an integration of many biological disciplines and bridges the basic and applied sciences
	Horticulture/Floriculture	1	120	120	The study of fruits (horticulture) and flower (floriculture).
	PCR Room	1	30	30	The multiplication of DNA is carried out in this space.
	Molecular	1	30	30	The process of DNA finger printing where the genetic profile of an organism is determined.
	GMO Transformation	1	70	70	The transformation of organism genetically.
	Proteomics	1	60	60	The study of the proteome, the complete set of proteins produced by a species, using the technologies of large-scale protein separation and identification



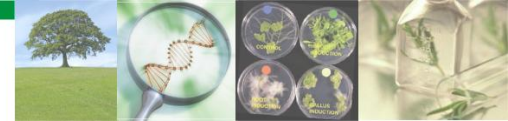
	Bio-Informatics	1	60	60	Analyze or predict the composition of molecules (nucleic acids, proteins, etc.) and model biologic systems
	Tissue Culture	1	120	120	refers to the technique of cell_culture, using cells dispersed from tissues or distant descendants of such cells.
Lab Supports	Histology	1	35	35	The study of cells and tissue
	Microscopic Room	2	35	70	Viewing of microscopic sample
	Slide Preparation	1	35	35	Before viewing under the microscopes, the materials are prepared and referenced.
	Incubator	2	35	70	Incubators are used for seed germination, growth and culture experimentation. It requires a clean air environment
	Gaschromatography	1	30	30	Chemical analysis of plants
	DNA Sequencing	1	30	30	This determines the DNA sequence of any organism.
	Lab Lockers	4	15	60	Researchers personal belongings and protection equipment are stored
	Dirty Utility	2	15	60	Cleaning equipment of laboratories are stored.
	Sample preparation and sample receival	1	25	25	The preparation of sample in liquid form and recording of sample from the field
	Quarantine room	1	15	15	Storage of samples in highly sophisticated equipment
Field					
	Agricultural Testing Field	1			Field where plants are tested in the natural environment
	Greenhouses	3	135	405	Storage of plants when still young



Research Offices					
	Open Plan	2	120	240	Space for researchers that are involved in team work projects
	Cellularised Offices	18	15	270	Office space for leaders of research groups and other senior staffs
	Discussion Rooms	2	30	60	Social space used as meeting room and informal discussions
Servicing					
	Mechanical Plant Room	1	400	400	Space with servicing equipment required to service laboratories
	Emergency Generator room	1	15	15	Storage for backup equipments
	Computer Server room	1	15	15	Space for computer network services
	External Gas storage	1	15	15	Storage space opening directly outdoor with gas cylinders supplying lab
	Laboratory Waste Storage	2	15	30	Solid waste disposal from laboratories that are stored temporarily until picked up for disposal in a safe location
Administration					
	Open Plan	1	100	100	Administration clerks space
	Cellularised Offices	5	15	75	Senior administration staff offices
	Discussion Room	1	30	30	Social space used as meeting room and informal discussions
	Filling Room	1	15	15	Fireproof storage of files and data
Social Utilities					
	Seminar Room	2	60	120	Space used as a presentation facility by senior



					researchers to external professionals
	Library	1	100	100	Mostly periodicals and journals would be housed where staff members and visitors could sit and read
	Restaurant	1	250	250	Social space with kitchen, indoor and outdoor eating facilities.
General					
	Ablutions	<p>Males: Urinal- 3 WC - 6 WHB – 5</p> <p>Females: WC- 9 WHB – 5</p> <p>Universal access: WC- 2 WHB- 2</p>			As per NBR Requirements for a population up to 120
	Parking	<p>55</p> <p>50-staff</p> <p>5-visitors</p>			Durban’s local council requirement is 4bays per 100sqm. By applying such requirements, it will end up with an over supply of parking facilities. Parking has therefore been restricted to occupied spaces. It should also be noted that public transport is safe and at a good standard in Mauritius. Thus, people tend to use such facility more than private cars.
Total Area				3400, excluding	g field and greenhouses
Including 10% Circulation				3750	



Design Concepts

Rearrangement of Function

Traditionally, various activities are usually grouped within the laboratory spaces. Offices are usually grouped within such space. However, the facts that laboratories consume a high amount of energy and due to the context, such extroverted spaces are relocated. Offices for the researchers overlook the walkway, facing north while the laboratories face south.

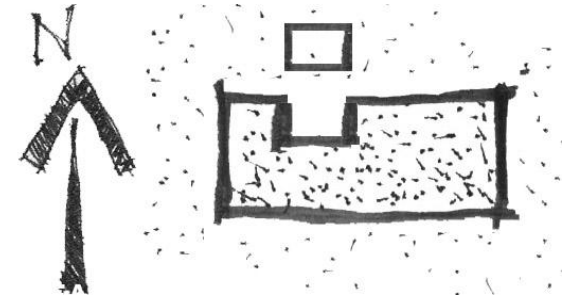
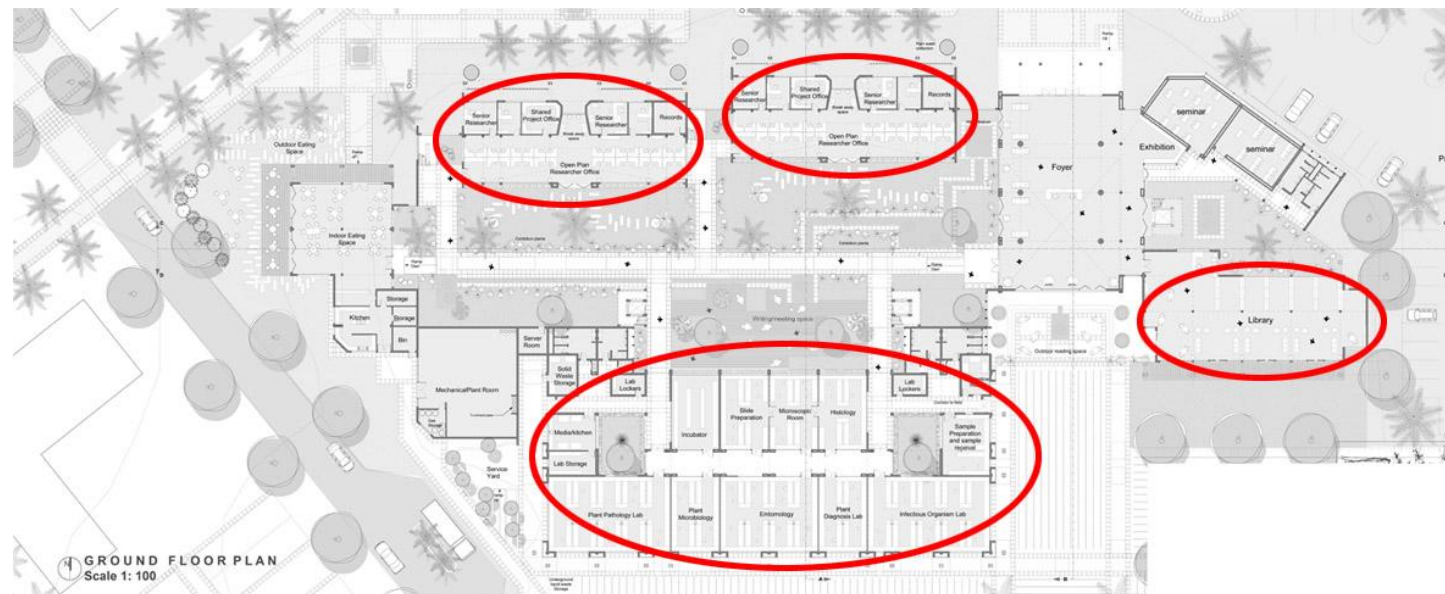
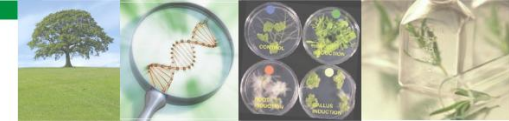


Illustration 13 and 14: Diagram indicating the rearrangement of functions, with offices facing the walkway, facing north while laboratory and library faces south





The Street

Research has revealed to be a social trend. It was therefore established that the design should promote social interaction. A conducive public domain was required. The concept of a street acts as that public realm, servicing humans through horizontal and vertical movement. Communal functions are located at both ends of the street, acting as magnets, encouraging users to walk onto the street. A bridge overlooking the street like balconies connect spaces above. An outdoor space along the street facilitates researchers to interact, allowing scientists to be more creative and discuss about research topics.

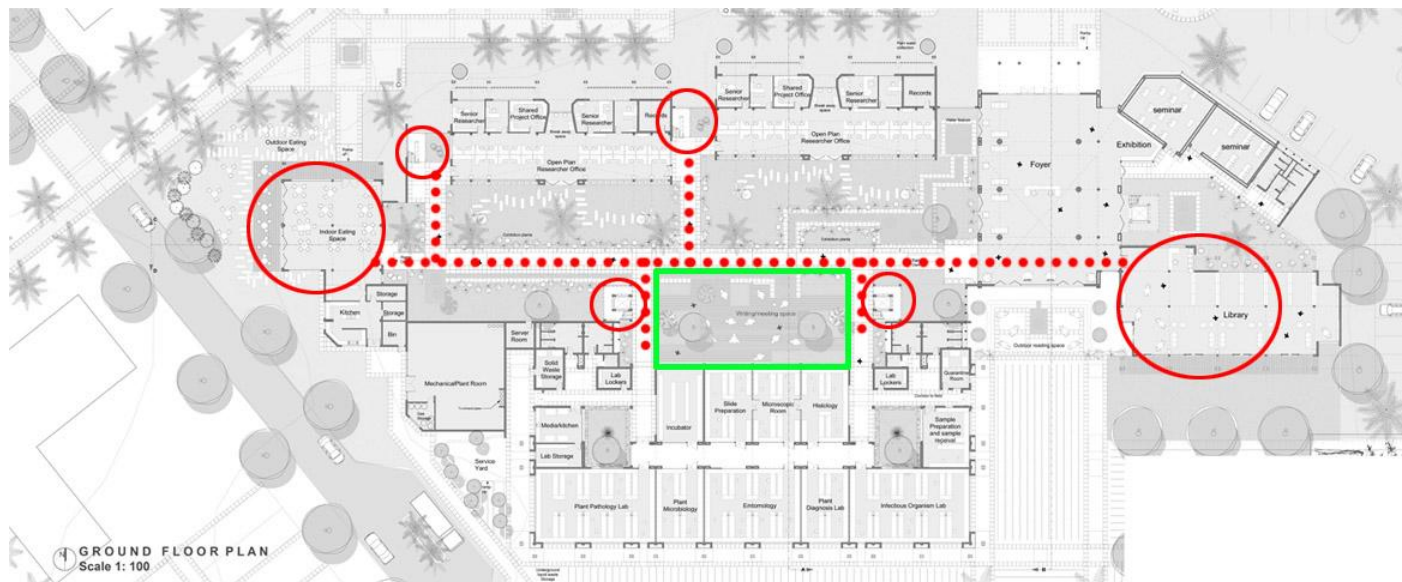
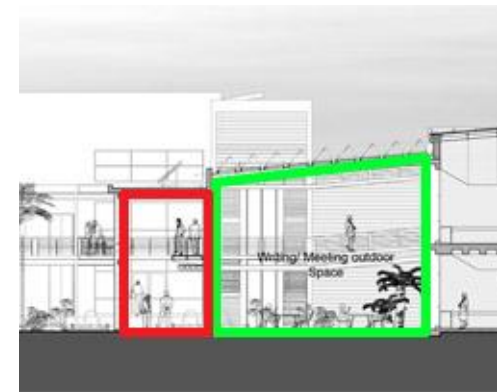
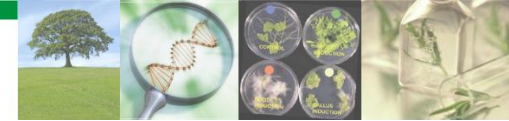


Illustration 15 (right), 16 (bottom): Diagrams indicating the stem of the building, which is a walkway, branching off to various spaces. The stem is characterised of lightweight construction, with bridges, overlooking the walkway. The library at the entrance and restaurant opening up to a boulevard of trees act as magnets along the stem, promoting movement of people along the stem. Outdoor space along the walkway.

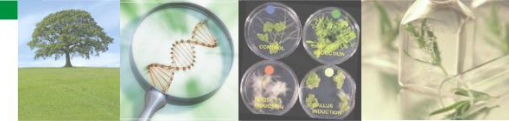


Green Lungs

The building is about researchers studying plants. The connection to the natural environment is therefore important. Green lungs are courtyard spaces, open to the sky, taking over the street. However, these are not ordinary courtyard spaces. Specimens being experimented in the laboratories are exhibited in the courtyard, where scientists can even discuss about plants being experimented and supervise their growth.



Illustration 17 (right), 18 (bottom):Diagrams indicating the use of courtyard spaces. These improve the ventilation strategy for extroverted spaces, while being a feature along the walkway.



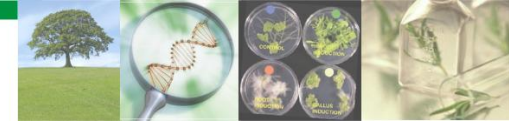
Transparency

Laboratories are introverted spaces, relying on artificial ventilation due to the type of experiments being conducted but also, due to its heavy servicing requirements, the creation of a conducive working environment is often neglected. In the design, the fact that the laboratories are facing south, transparency is used along the external perimeter, promoting the connection to the natural environment. For security reasons, workers in the laboratory should be exposed, where scientists dealing with hazardous chemicals can readily be seen. An internal corridor within the laboratory block with glazed surfaces, expose workers in the laboratories to the corridor and along the street. Glazed partitioning is also used.

Transparency is also about creating an open and permeable environment. The foyer is traditionally a small restrictive space, opens up to the agricultural field, with a space where informal meetings can occur with other fellow researchers from other facilities.



Illustration 19: Diagram indicating the use of transparency, allowing the connection to the natural environment. Transparency is used in the lab, where it not only allows such connection, allows the penetration of natural light but also expose the researchers dealing with hazardous chemicals can readily be seen. Outdoor space by foyer overlooking testing field where discussion with visitors can occur



Servicing

Waste elements are in the form of solid, liquid and gases. The current trend is to have a one-line system, with entry of specimens on one side and outgoing specimen or waste on the other. Such approach improves the cleanliness of the laboratory and movement of specimen.

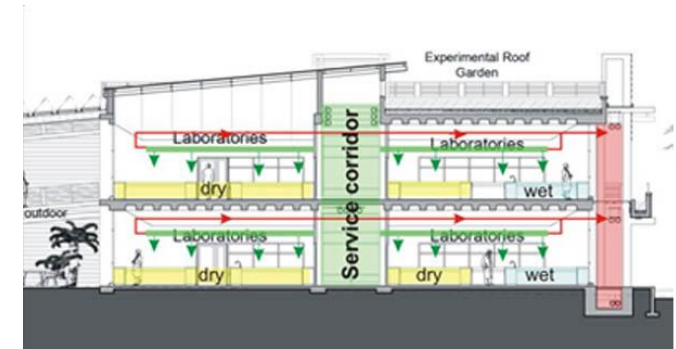
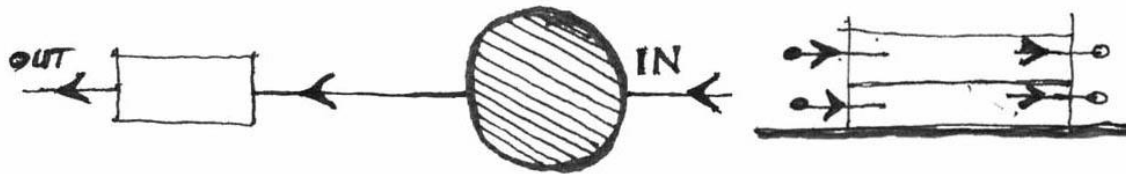
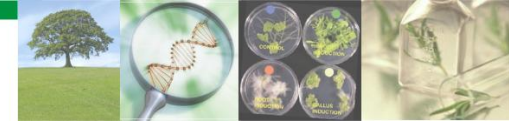


Illustration 20 (left), 21 (Right): Diagram indicating the process of laboratory servicing, with a one line system. Sample coming either from the field or prepared on one side and is processed through the various laboratory spaces. Samples are tested and their waste is stored. These are collected on a weekly basis. Servicing of lab is indicated on the left, with outward waste running along the external service corridor (in red). More details see Appendix



Sustainable Approach

Orientation

With the laboratories facing south, the thermal mass gained on that section is reduced. A roof garden is located above a portion of the laboratories; this not only is used as an experimental roof garden but also improves the thermal reduction of the building. Extroverted spaces open to the north and the walkway, allowing natural light and ventilation to flow in. The institute is located in a tropical island. The sun is expected to be harsher compared to Durban. Large overhangs are used to reduce sun penetration in summer (Refer to appendix A for solar study).

Rainwater Collection

Harvesting natural resources such as rainwater will be consumed. Such resource will be used to water the plants and for any other means. This will reduce the water consumption by the institute.

Photovoltaic Panels

Photovoltaic panels are used to generate electrical energy to be consumed in offices, seminar rooms and library. The laboratories are high consumable of energy and the one generated by the photovoltaic panels will not be sufficient for the labs. Electricity from the municipal line will be used in such cases.



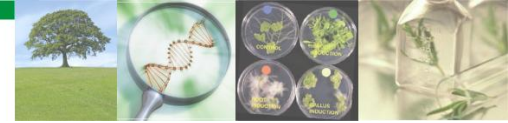
Illustration 22: Plan illustrating introverted spaces facing south while extroverted spaces facing north



Illustration 23: Rain water collection exposed to the walkway

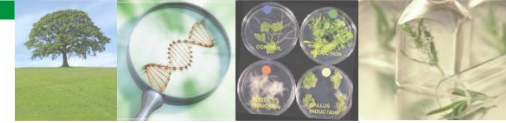


Illustration 24: Photovoltaic panels fixed on concrete slabs



Materials

The use of brick infill compared to concrete blocks is preferable. Compared to concrete blocks, bricks have a low thermal mass, thus, reducing the thermal gain in the various components of the building.



Structure

An unusual approach to the structural planning is laid due to the 1.5m module on which laboratory space is laid out. A 6.6m grid allows for such modules to work but allow allows for flexible laboratory space.

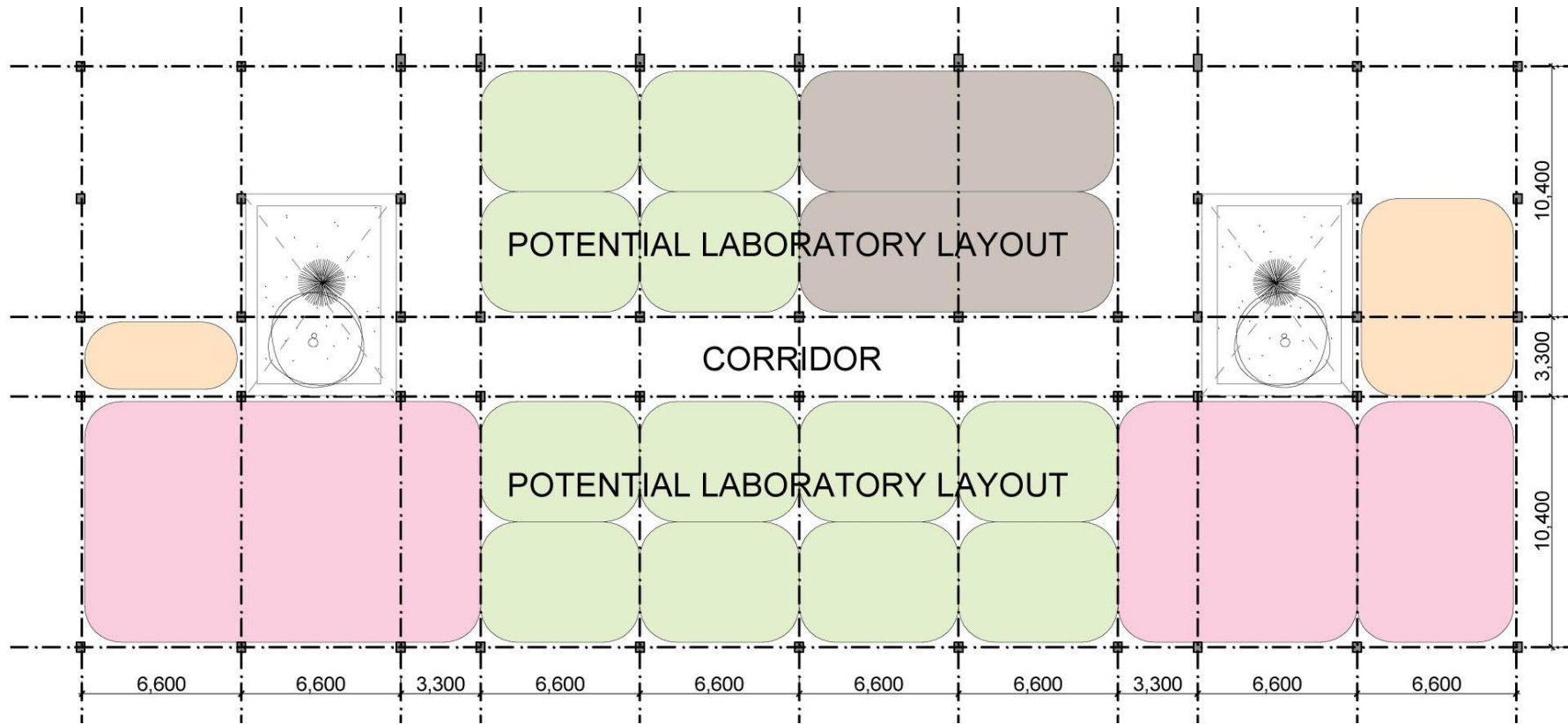
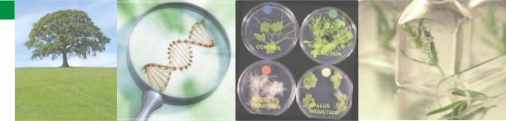


Illustration 25: Structural resolution of the lab with potential laboratory layout being indicated



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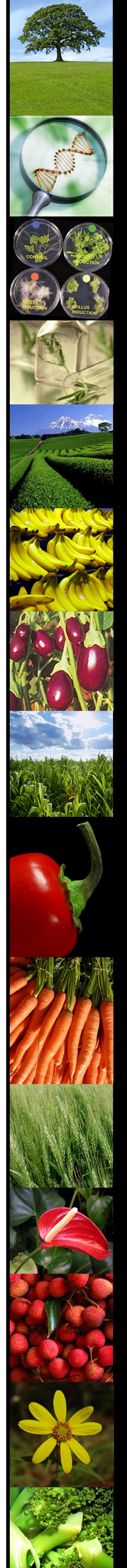
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Introduction

a new plant biotechnology institute for mauritius



Background analysis: Agriculture is an important key element in the socio-economic development of Mauritius. Agriculture has evolved with time, from the traditional cultivation of plants and rearing of animals, the scientific agricultural applications to modern technology application, that is, biotechnology. It is the application of genetically modifying the DNA characteristics of a living organism through advanced scientific application. "Biotechnology in agriculture is now recognised by the international scientific community to be an essential and increasingly important element of a critical strategy, integrating both conventional and biotechnological applications, in order to achieve food security." (MAFTNR 2003: 165). It is a new technology used for food safety. According to agricultural statistics and from the SAC meeting that was held in Mauritius in 2008, there is not enough food to feed the whole world, specially in african countries. This shortage of food is also affecting the economic growth of countries like Mauritius, who used to export sugar, tea, anthurium and tropical fruits. It is difficult for such an emerging country to reach its exporting quotas due to plant diseases, climatic interference and price competition.



Identifying the problem: The approach to agriculture in Mauritius has generally remained traditional. Brazil and the United States of America has already invested in biotechnological applications. The Government of Mauritius in collaboration with the Ministry of Food Technology and Natural Resources (MAFTNR) are now insisting on such technological applications. The country's exporting quotas has reduced drastically, thus affecting the economic growth. There is an urgent need for a biotechnological institute that would help the agricultural sector.

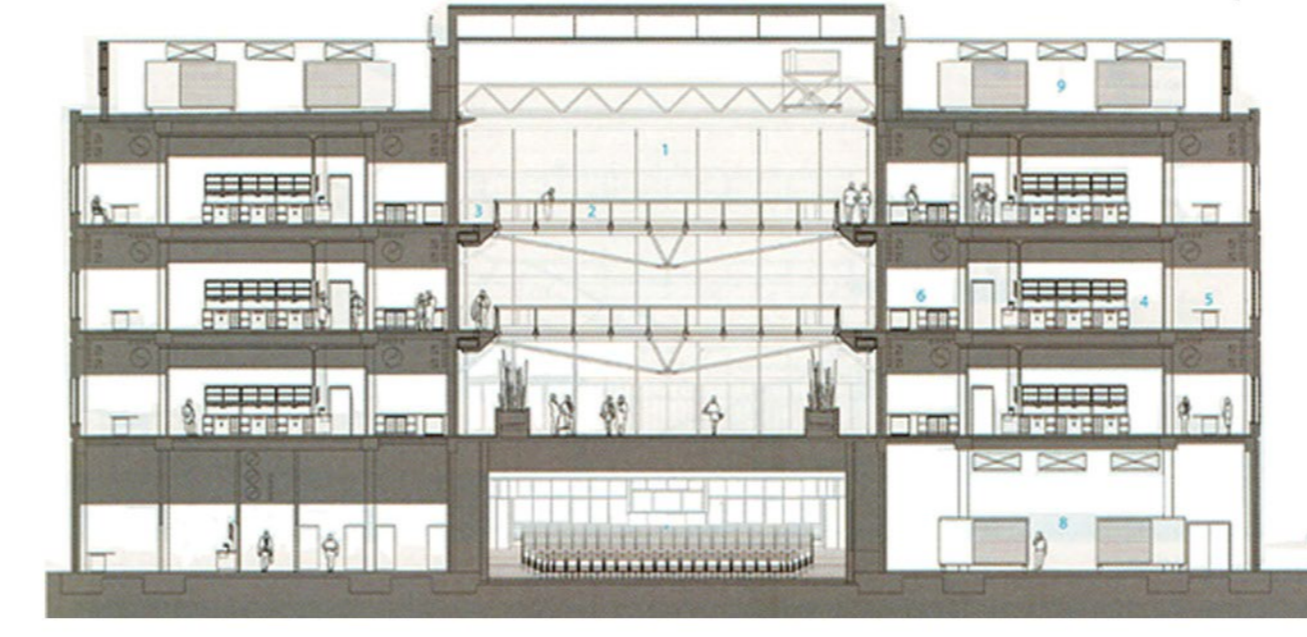
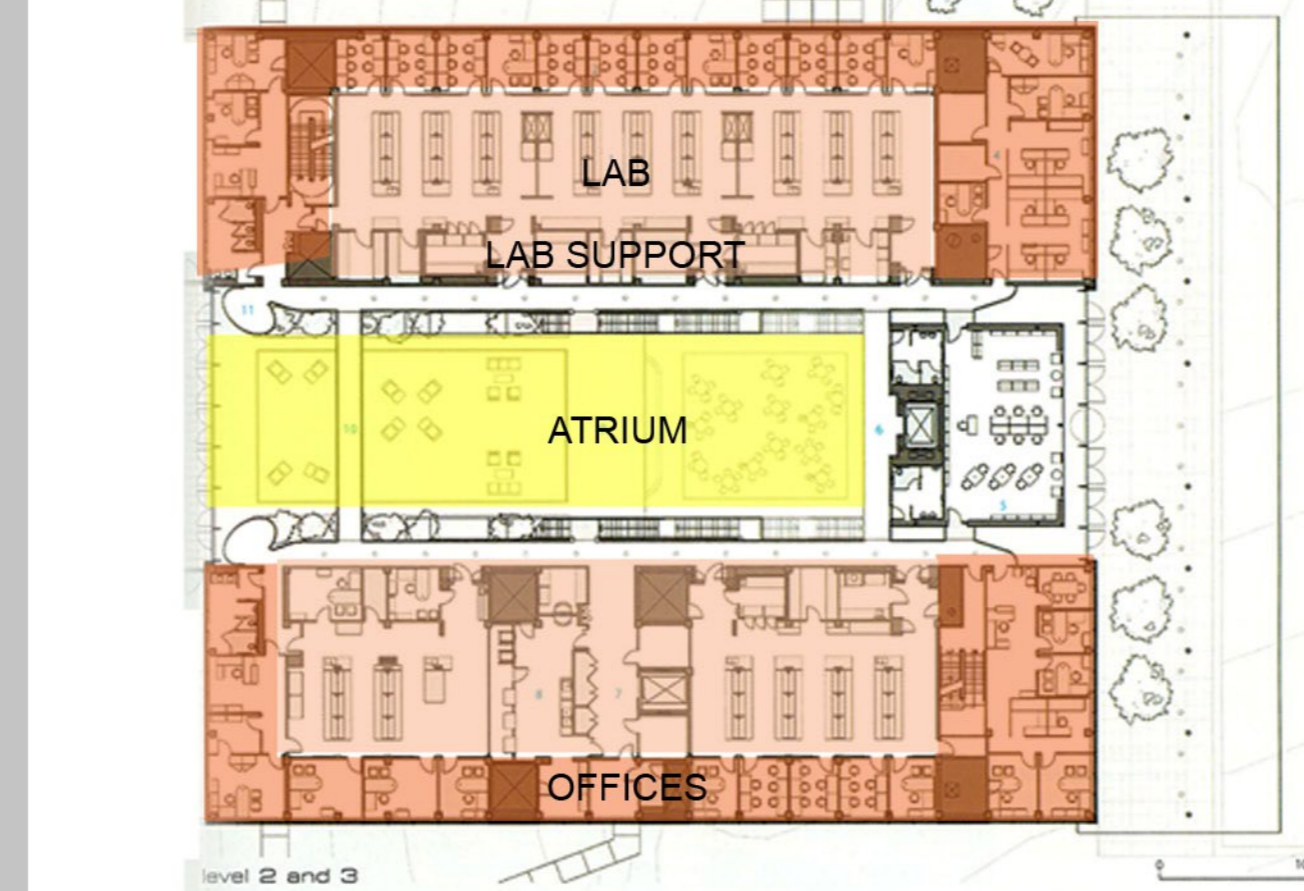
ITEMS	1997	1998	1999	2000				
Value	%	Value	%	Value	%			
Sugar	7,495	23.53	8,007	23.66	7,602	20.16	5,539	14.69
Molasses	102	0.32	70	0.18	26	0.07	45	0.12
Tea	13	0.04	10	0.03	8	0.02	5	0.01
Vegetables & Fruits	26	0.08	45	0.12	50	0.13	46	0.12
Cut Flowers and foliage	130	0.40	136	0.56	124	0.33	133	0.35
Other Agricultural and food Products	611	1.91	477	1.26	563	1.49	685	1.81
Sub Total	8,378	26.30	9,645	25.60	8,373	22.20	6,453	17.10

Source: CSO - Digest of Statistics

The Proposal: The long term survival and future of the mauritian agricultural sector should be envisaged. The Government of Mauritius came up with a proposal to initiate a Biotechnology Institute and its role is to examine and research possibilities regarding the survival of various plants and improving their quality. This dissertation will work towards the design of a new Plant Biotechnology Institute, consisting of laboratories, offices, a library, seminar rooms and a restaurant. The client's brief is to design a building that promote congenial humane environment, a good servicing strategy for the laboratories while encouraging flexibility within such spaces; safety for the staff and visitors and planning and environmental considerations. The need to analyse precedents and case studies is critical in the design process of the new facility.

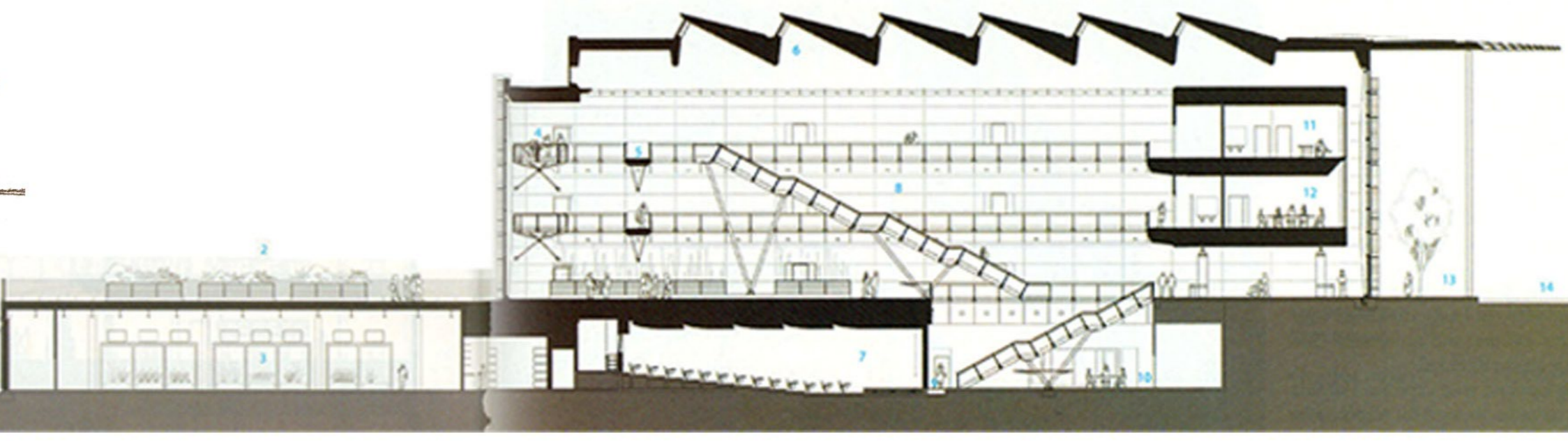
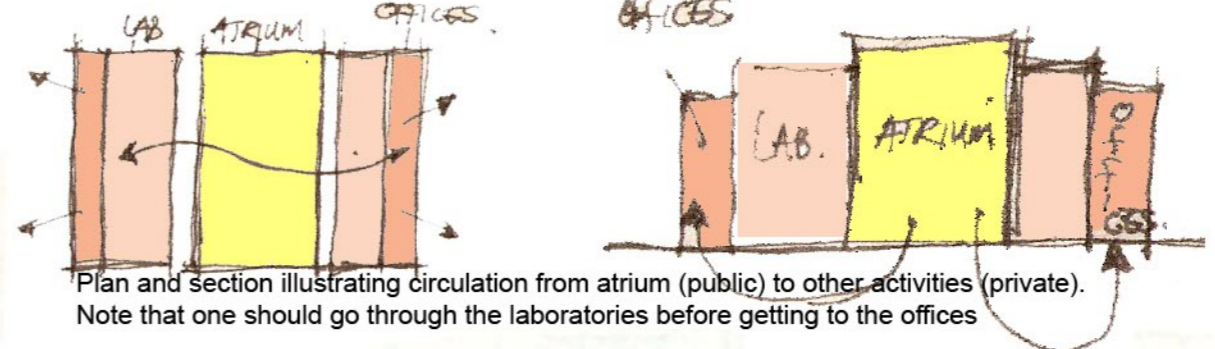
precedents and case studies

PRECEDENT: DONALD DANFORTH PLANT SCIENCE CENTRE, USA- ARCHITECT: NICHOLAS GRIMSHAW

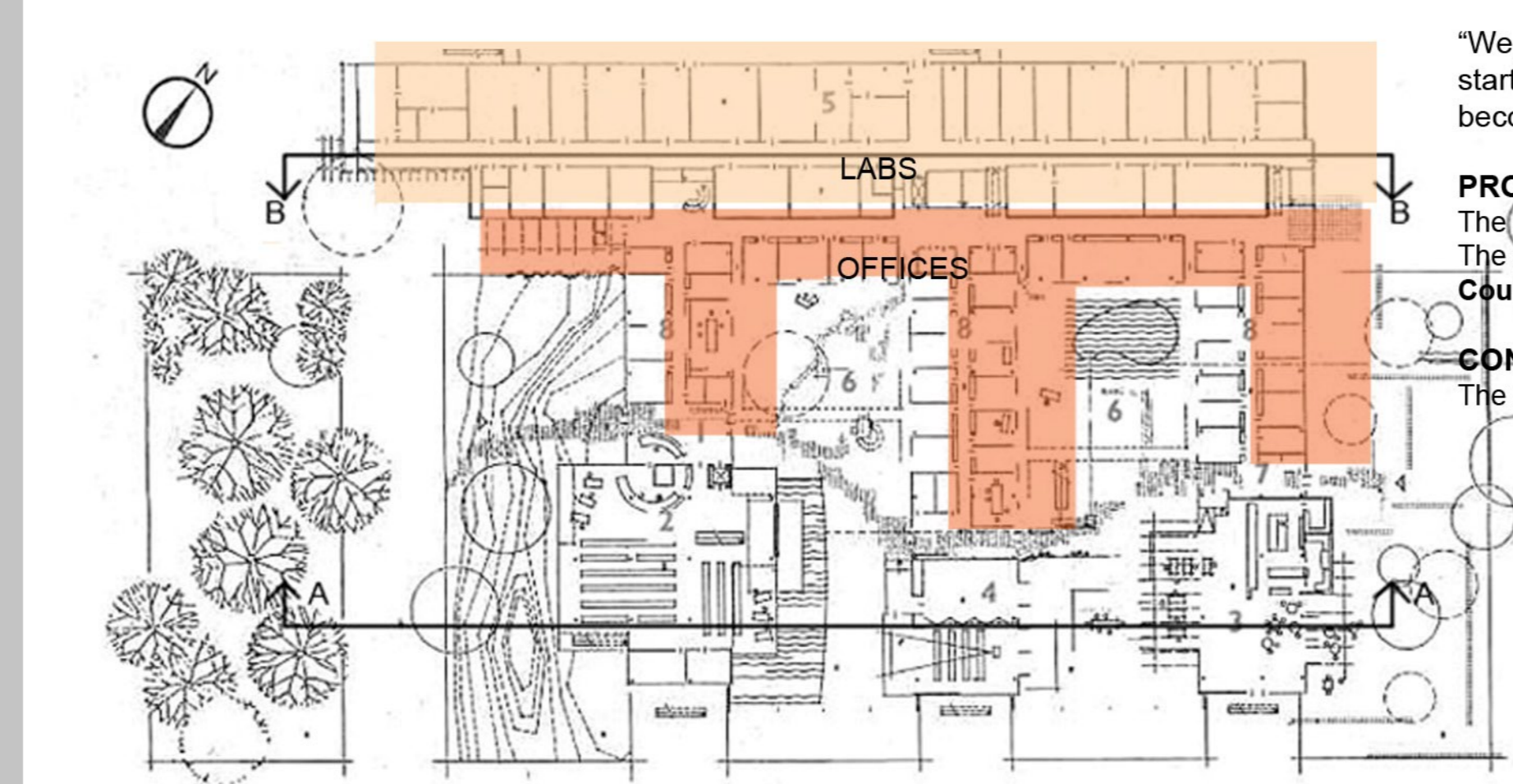


The Donald Danforth Plant Science Centre laid out design goals within their brief: "First, they wished to create an open and accessible environment, giving the public maximum opportunity to use its facility. Second, they wanted to establish a working environment that would allow scientists to explore and exchange ideas within a community dedicated to advancing the science and understanding of man's reliance on plants." (Source: www.danforth.org).

PROS:
The use of an atrium as a means to access the various spaces connected to it but also becomes an important social element
Lab support spaces are specialised resources for researchers are separated from the laboratory space, allowing more flexibility
The provision of meeting nodes where scientists can meet and discuss about their work.



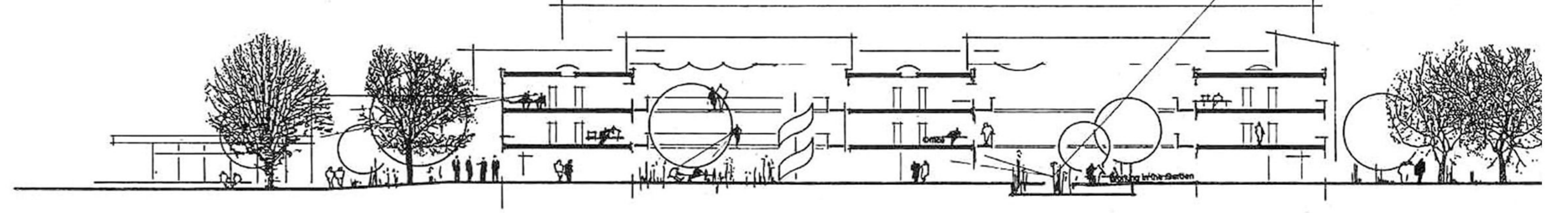
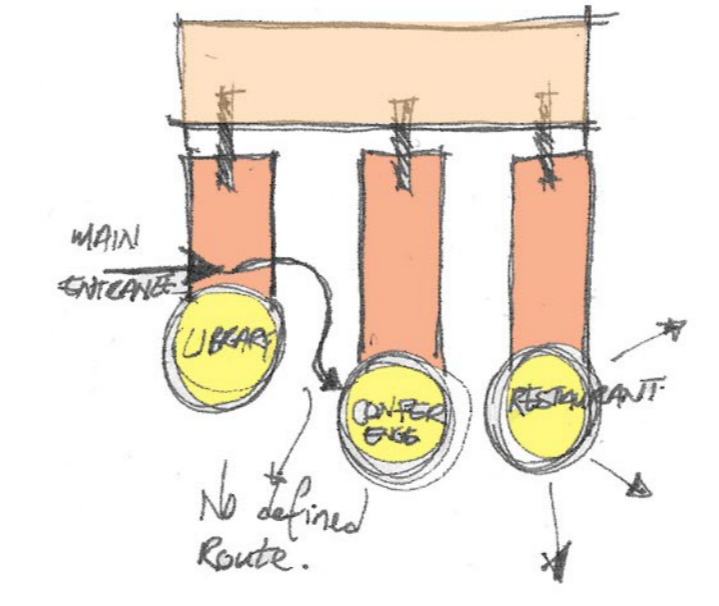
PRECEDENT: INSTITUTE OF FORESTRY AND NATURE RESEARCH, NETHERLAND- ARCHITECT: BEHNISCH, BEHNISCH & PARTNERS



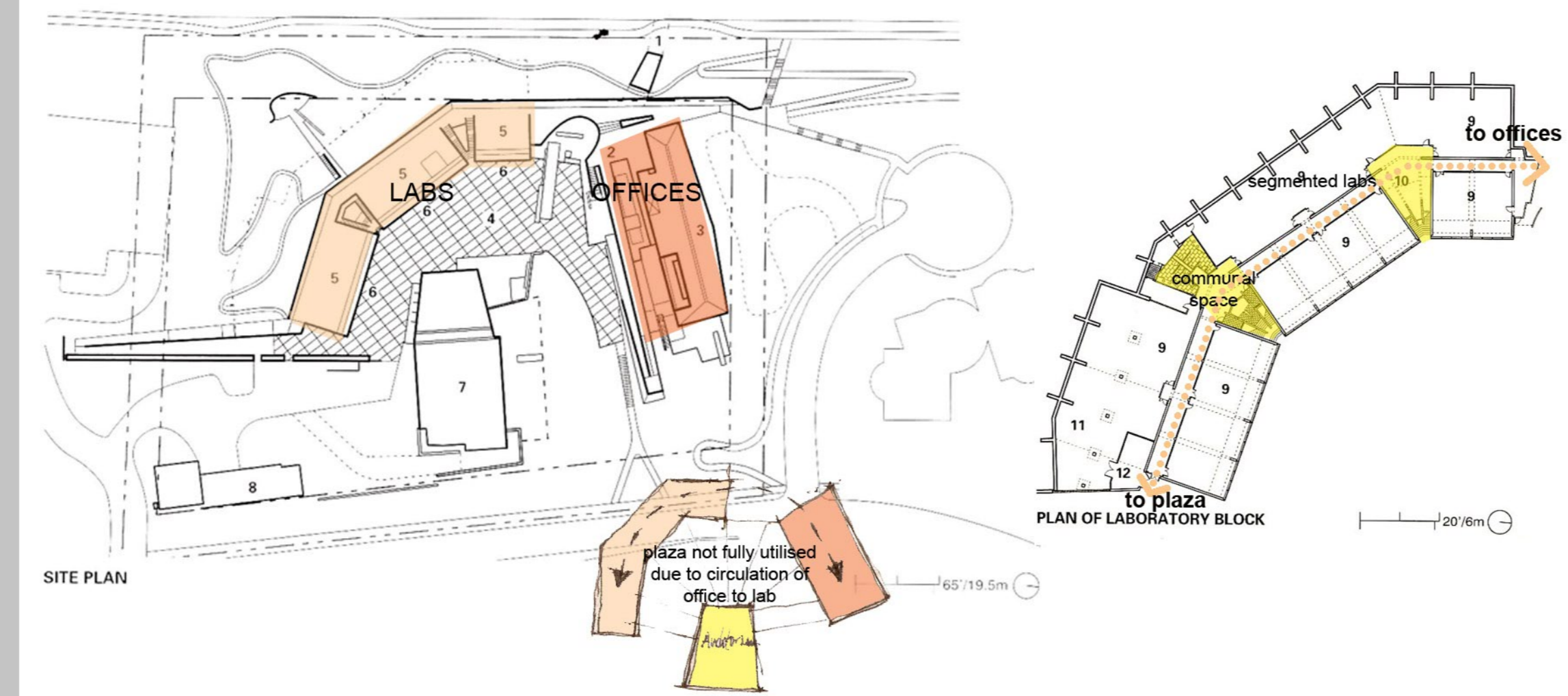
"We, as architects, are driven by the belief that our surroundings directly influence the quality of our lives, whether in the work place, at home or in the public spaces in between. This emphasis on the social dimension is fundamental to our design philosophy, which takes as its starting point the acknowledgement that architecture is generated by the needs of people, needs that may be spiritual as well as being material." (Source: www.behnisch.com). The aim is to respond uniquely to specific demands of project and place. The result is a building which becomes over time a familiar and symbolic landmark, respecting the 'genus loci'. They stress that "all architects should be practicing responsibility." (Source: www.genzyme.com).

PROS:
The separation of offices to lab spaces allows for less energy consumption.
The office layout promotes natural ventilation and natural light
Courtyard spaces created between the office wings are treated as an extension of the workplace for lunch, meetings or readings but also provide views to the staff through their intimate offices

CONS:
The building is permeable and anybody can reach to the offices through the courtyard spaces.



PRECEDENT: NEUROSCIENCE INSTITUTE, CALIFORNIA- ARCHITECT: TOD WILLIAMS & PARTNERS

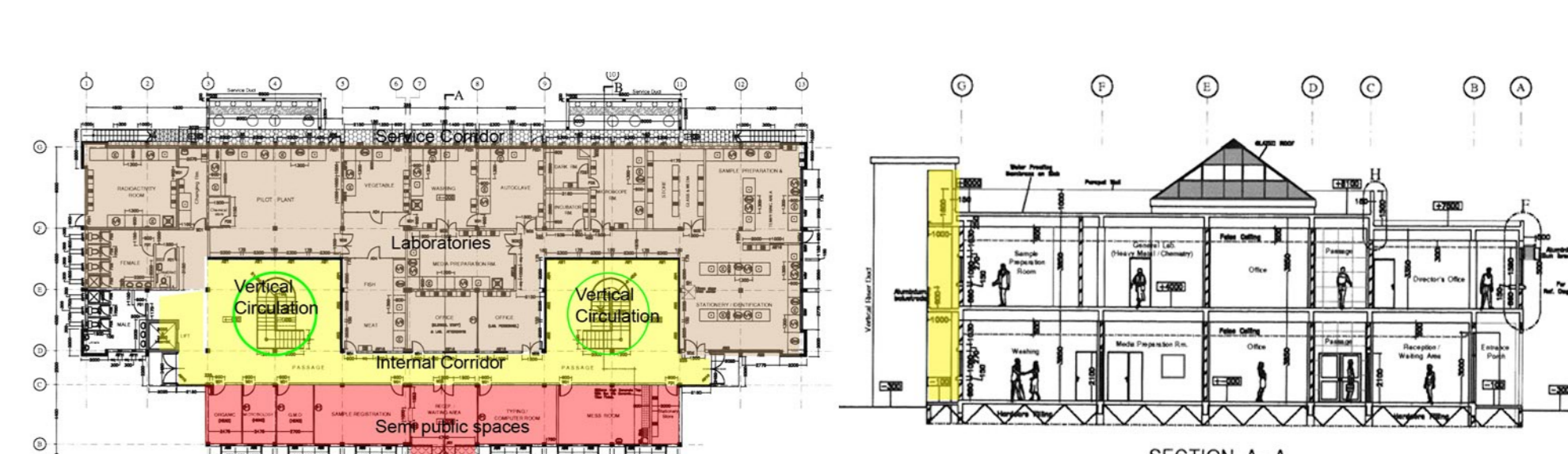


Tod Williams created three buildings that are barely noticeable from the street (illustration 4.4.3). These structures are: a raised Theory Centre, a U-shaped line of buildings oriented east towards the mountains is the laboratory wing and an auditorium at the centre of the scheme surrounded by a plaza. These are sunken into the landscape where portions of the building can only be seen from walkways, balconies, staircases and ramps descending into a central courtyard.

PROS:
The plaza is an important feature in the design overlooking a view. By separating the spaces, the plaza becomes an external corridor that linked to them.
The labs being on its own allows for flexibility

CONS:
The scheme surrounds an auditorium that is occasionally used. There is no extra public space that could attract staff to the plaza

CASE STUDY: FOOD TECHNOLOGY LABORATORY- MAURITIUS

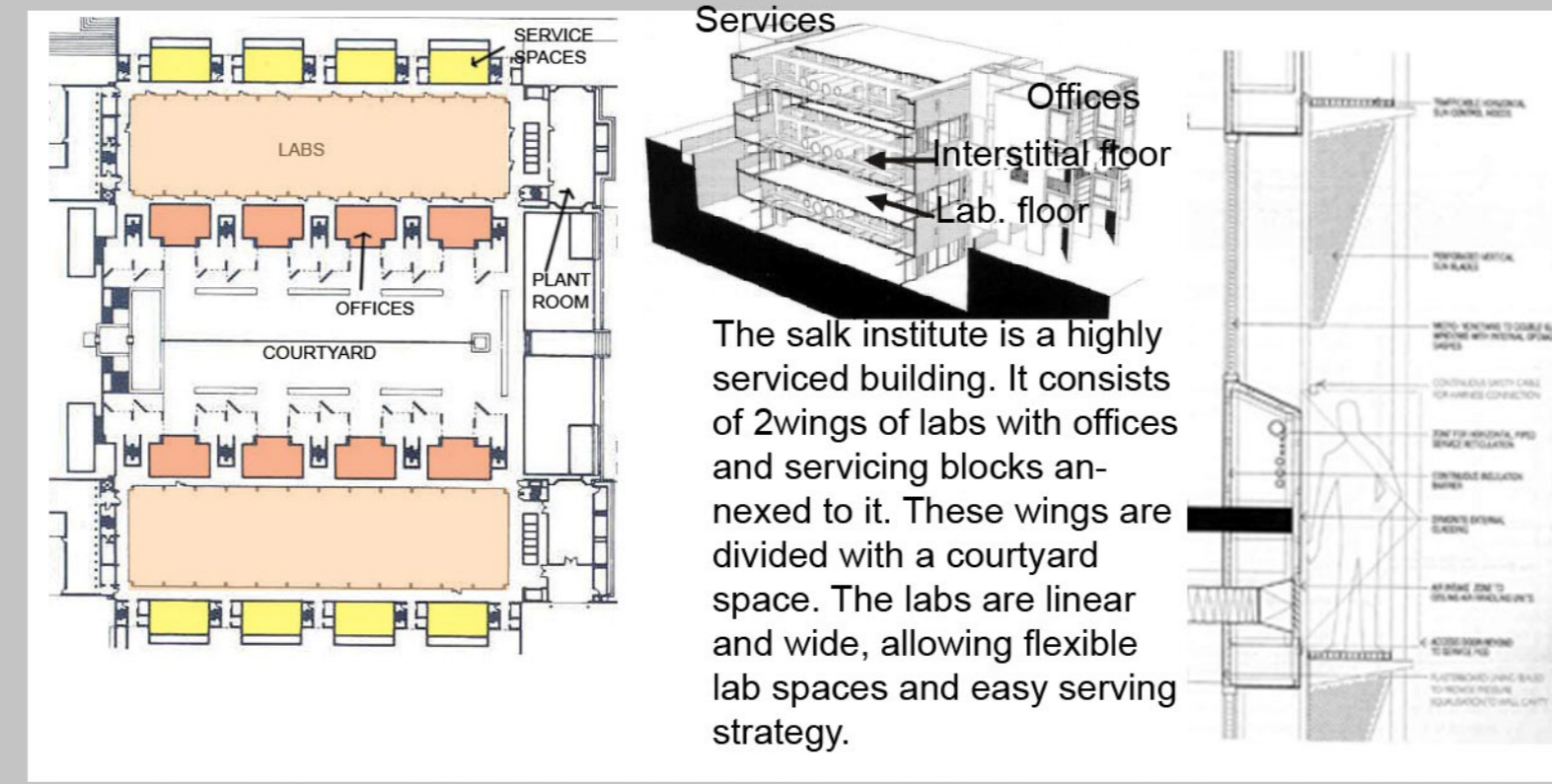


The driving concept in the building was the building norms, that is, the technical requirements for laboratory design. This resulted in a very practical building with a lot of emphasis laid on services. A simple grid structure was used. Three basic elements have been used in this design: The semi private spaces facing the road, The internal corridor feeding the various spaces within the building and the laboratory block.

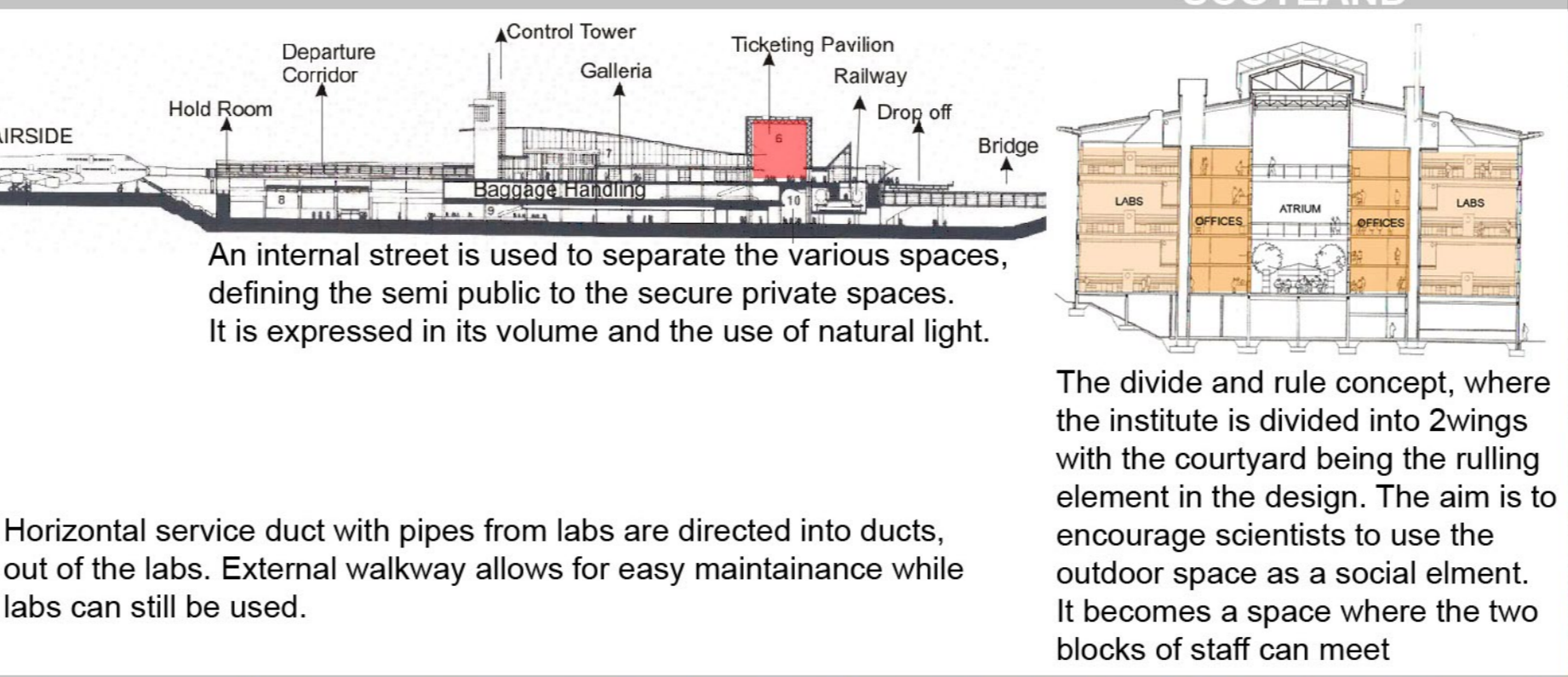
PROS:
The use of aluminium panels to reduce the heat gain by the building.
The vertical service tower blocks with a service walkway facilitating the servicing of the laboratories.

CONS:
There is no meeting points where scientists can gather, specially, outdoor spaces where they can spill out due to the hot and humid weather conditions in Mauritius.

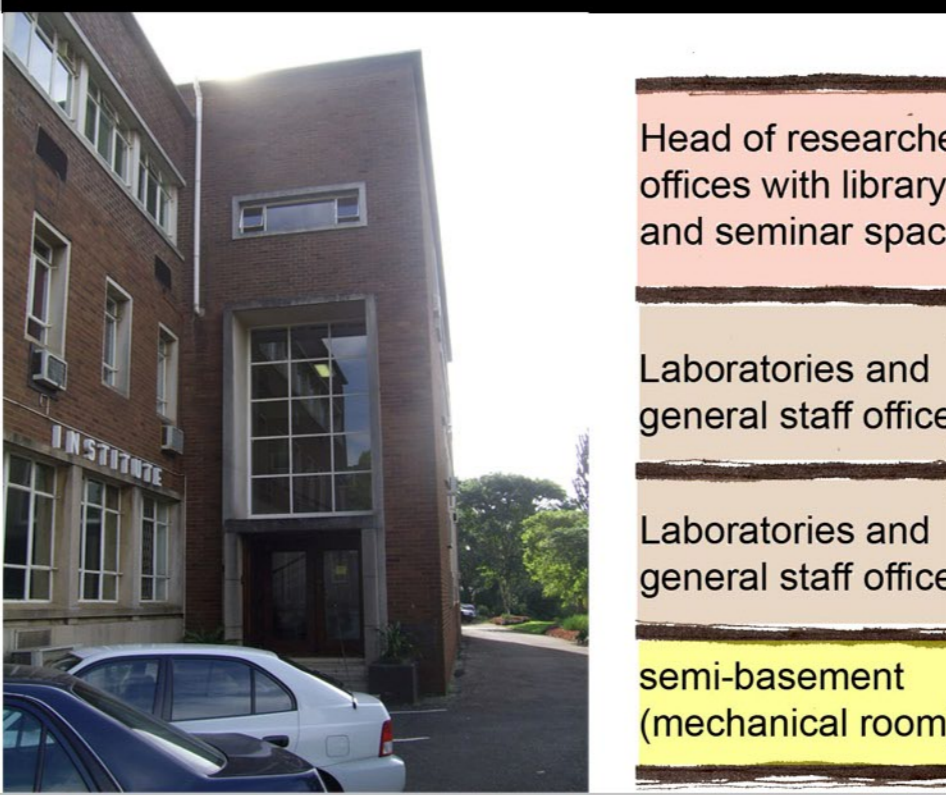
SALK INSTITUTE, CALIFORNIA- LOUIS KHAN



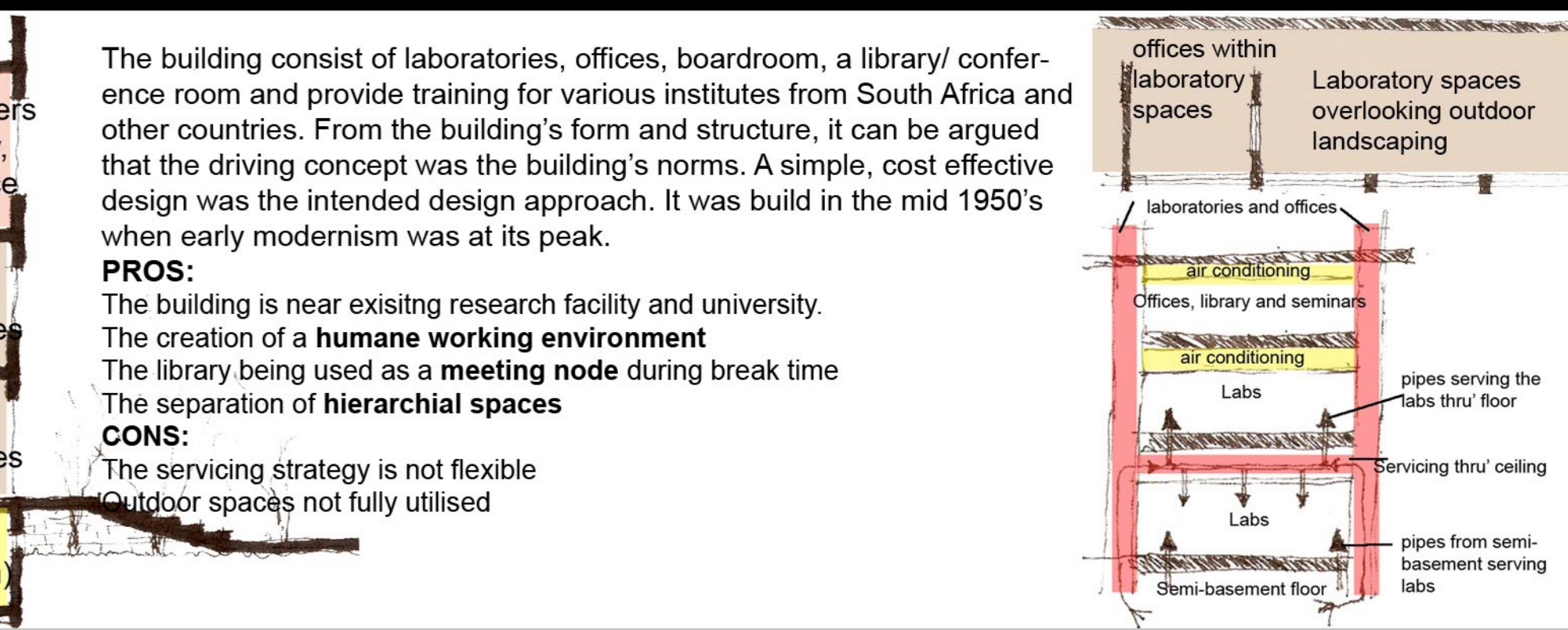
O HARE INTERNATIONAL AIRPORT



INSTITUTE OF MEDICAL SCIENCE SCOTLAND



CASE STUDY: SUGAR MILLING RESEARCH INSTITUTE- DURBAN



Head of researchers offices with library and seminar spaces
Laboratories and general staff offices
Laboratories and general staff offices
semi-basement (mechanical room)

The building consist of laboratories, offices, boardroom, a library/ conference room and provide training for various institutes from South Africa and other countries. From the building's form and structure, it can be argued that the driving concept was the building's norms. A simple, cost effective design was the intended design approach. It was built in the mid 1950's when early modernism was at its peak.

PROS:
The building is near existing research facility and university.
The creation of a humane working environment
The library being used as a meeting node during break time
The separation of hierarchical spaces

CONS:
The servicing strategy is not flexible
Outdoor spaces not fully utilised

other precedents



design primer

DISSERTATION 2009
by afzal soobrattee

flexible laboratory spaces
modular grid structure and workbenches

materials

circulation

introverted/extroverted spaces

separation of functions

formal/informal interactions

meeting nodes

conductive working environment

natural light and ventilation

courtyard spaces

colour

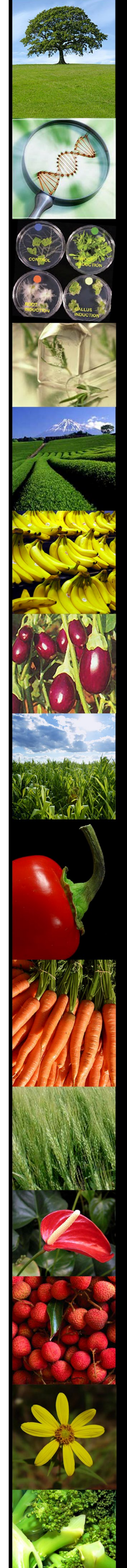
transparent environment

servicing

flexible servicing interstitial space

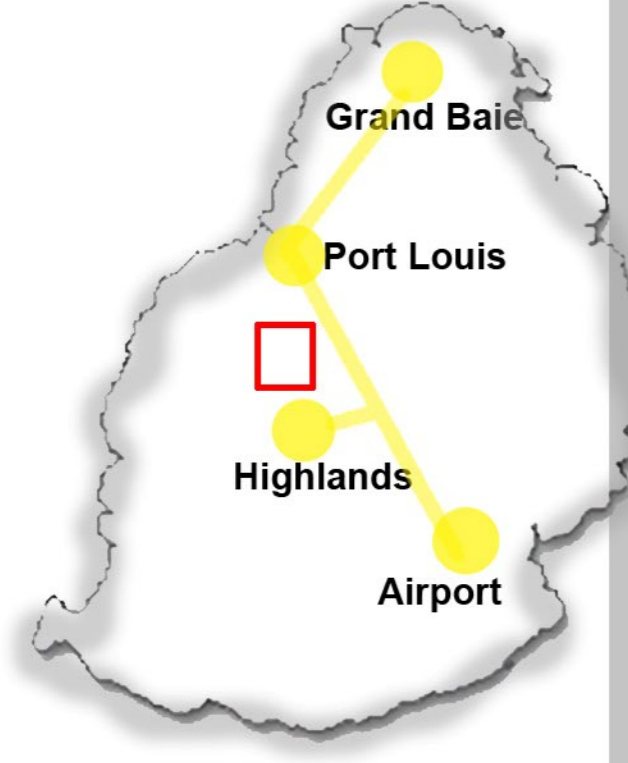
in-out: samples, water, gas

Research Institute



Macro Contextual Analysis

Geography of Mauritius: Mauritius is on the latitude of 20°S and longitude 58°E. Surrounded by calm, blue sea water, Mauritius is an ideal tourist attraction to the world. Hotels and bungalows are define the coastal line. The only highway is from the airport, crosses the capital city terminating in the northern part of the island. The upper highlands is characterised mainly as a commercial and residential area. Port Louis, the capital city is the economic heart of the island. Various activities are based



Climatic Conditions, water and energy
Mauritius is a tropical island with a hot and humid climate. Due to its location, the country also experiences cyclonic conditions in the summer seasons. The country rely on boreholes and reservoirs for collection to be distributed to the people. Electrical energy is produced by either the burning of bagass from the sugarcane production or the use of hydro-electric terminals.



Cultural Background and safety
The country is made up of a multi-ethnic society, comprising of various religious faiths living together. Its characteristics lies in its diversity of communities and respect for others. Although of this difference in cultural background, the people are very friendly, and peaceful. This friendliness and safety is due to its urban fabric structure: houses being at the edge of the street, the location of small shops ("La boutik") at various section of streets, encouraging people to come onto the street, specially during summer seasons.



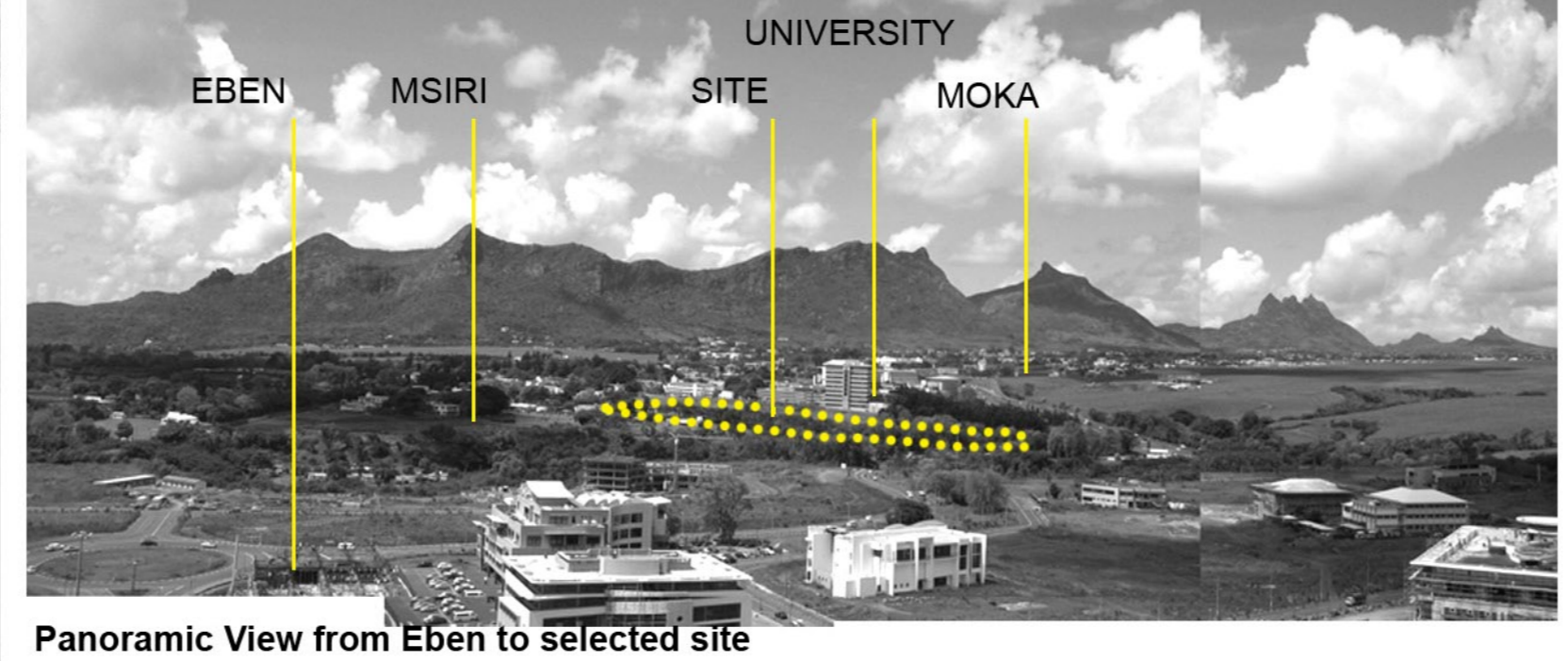
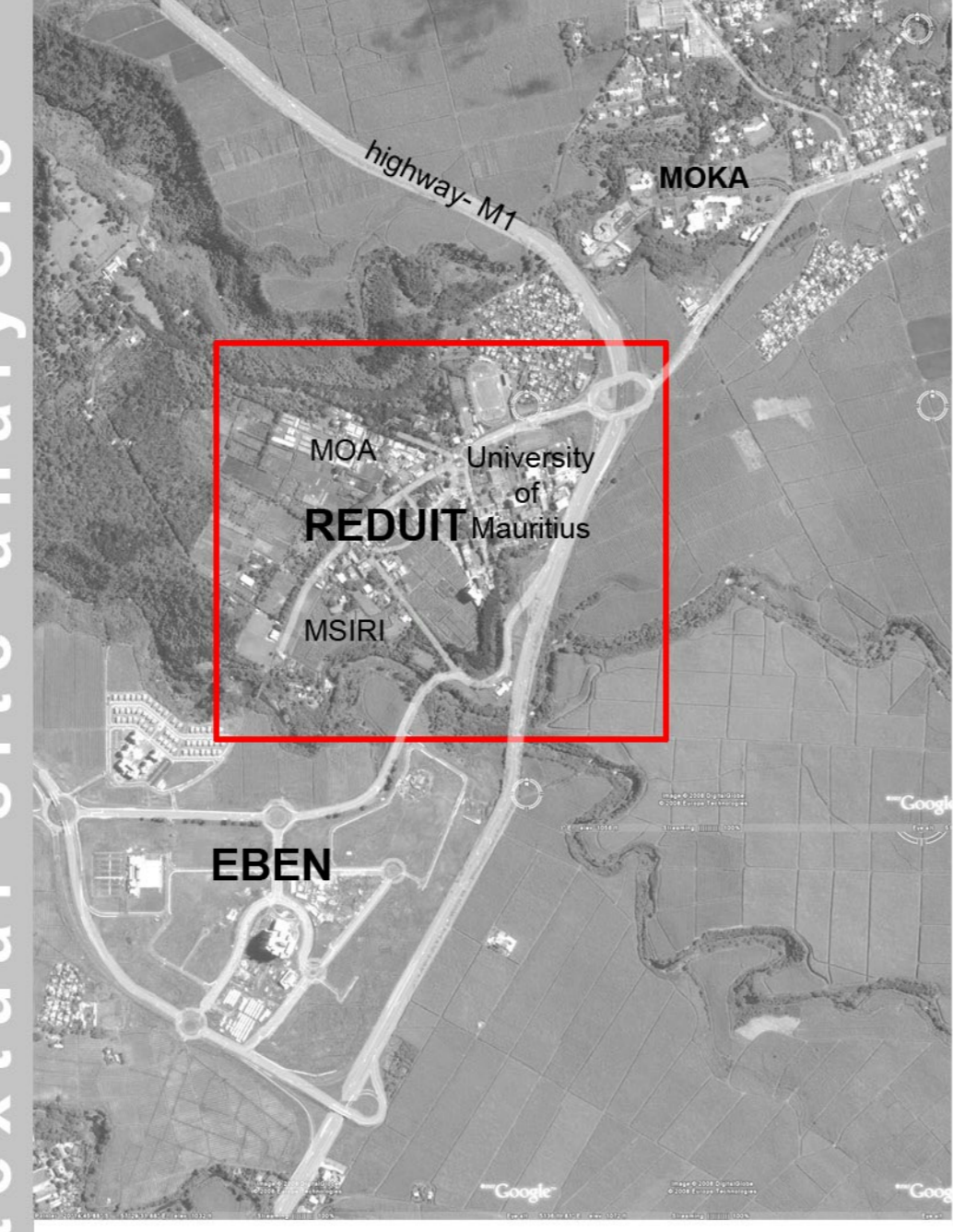
Transport System
Mauritius has an excellent public transport system. It is safe, liable and cheap for anybody. Such transport system is achieved with buses that are reached on bus stops anywhere on the island. People rely on such system to go to work and school. Furthermore, it is safe for pedestrians to walk during both, day and night. The country is mostly flat facilitating such pedestrian movement.



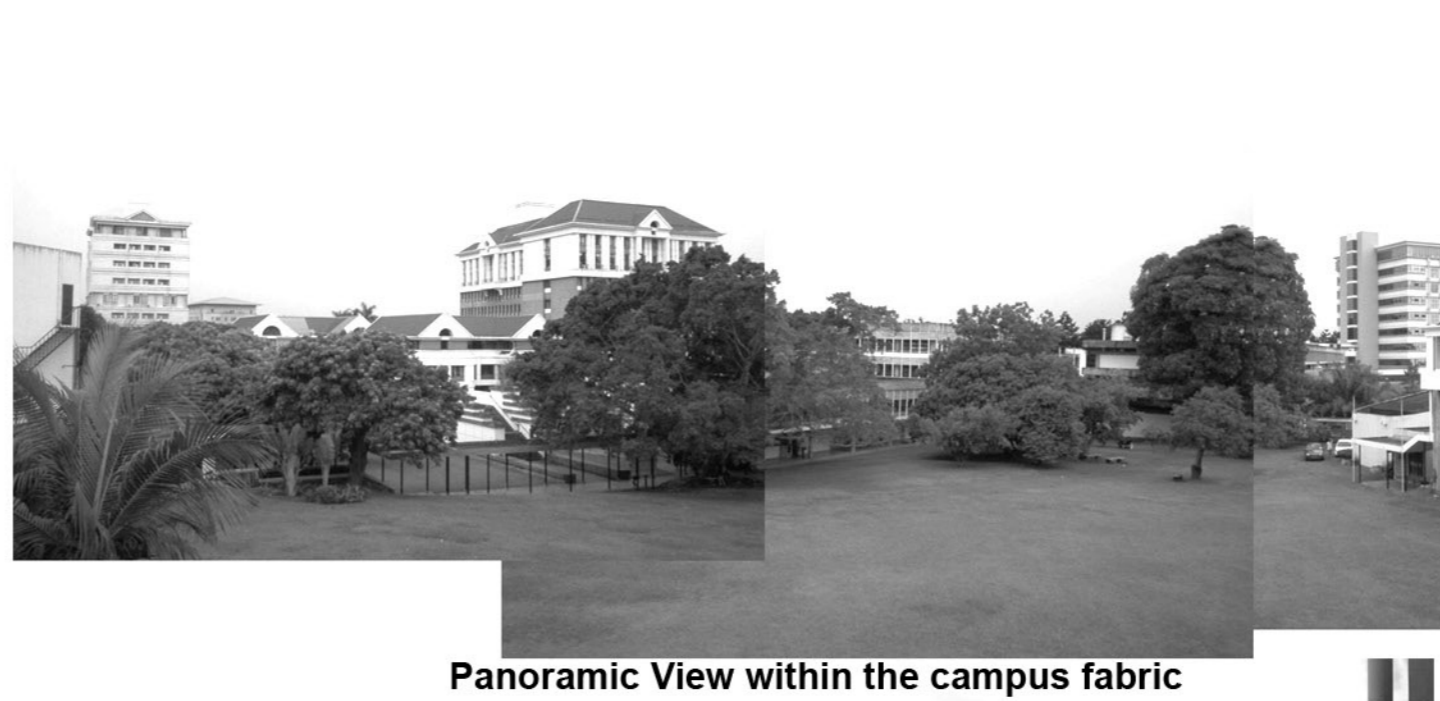
Materials
Mauritius is known for its typical colonial architecture. Such approach evolved to concrete walls and roofs as the island experience cyclonic conditions. Concrete is more resistant to cyclonic conditions. Residential, commercial and office buildings in Mauritius are constructed mainly with concrete blocks as walls and concrete roofs. The country is now moving to advanced materials such as steel, aluminium panels and bricks.



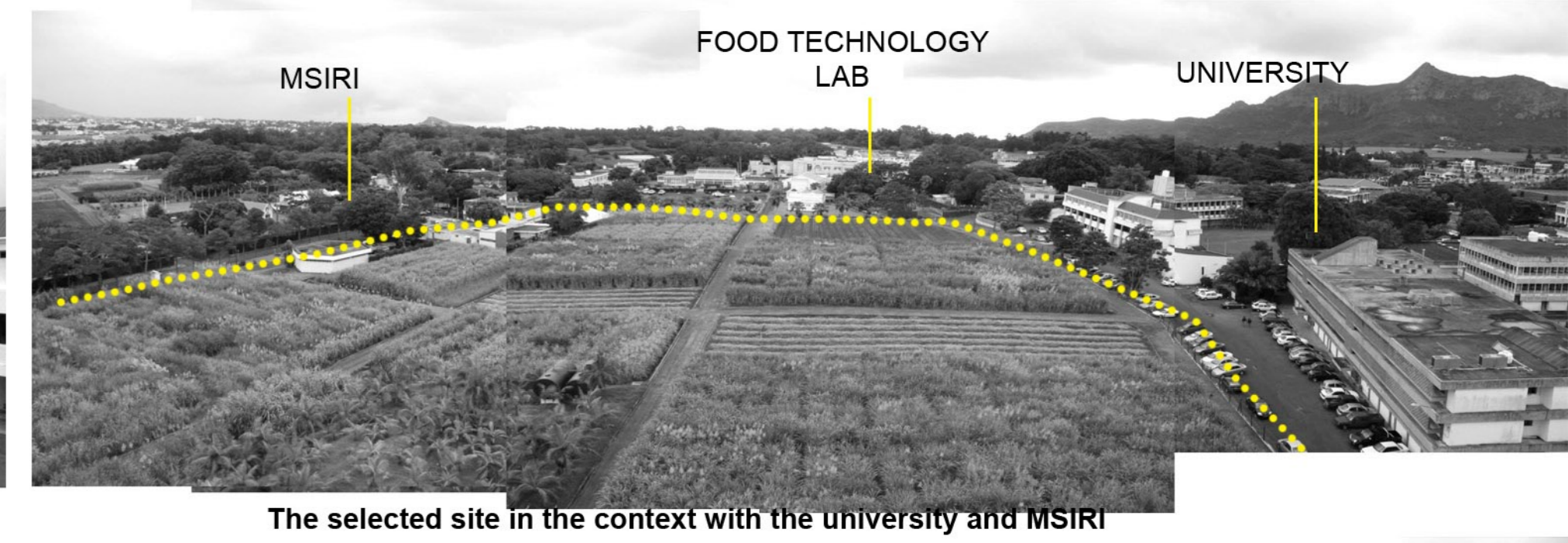
contextual site analysis



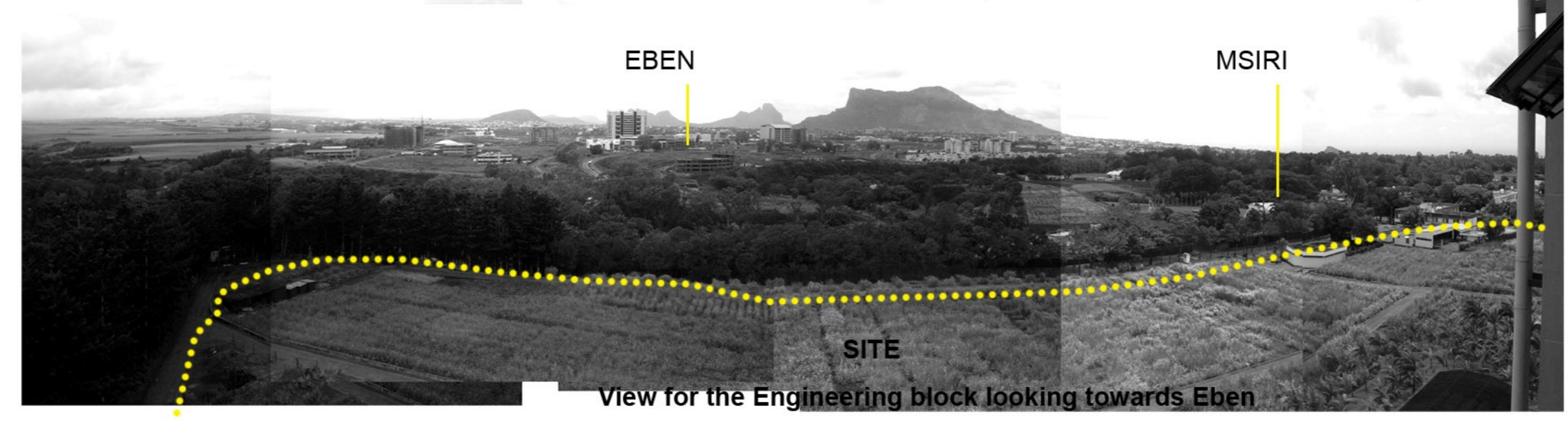
Panoramic View from Eben to selected site



Panoramic View within the campus fabric



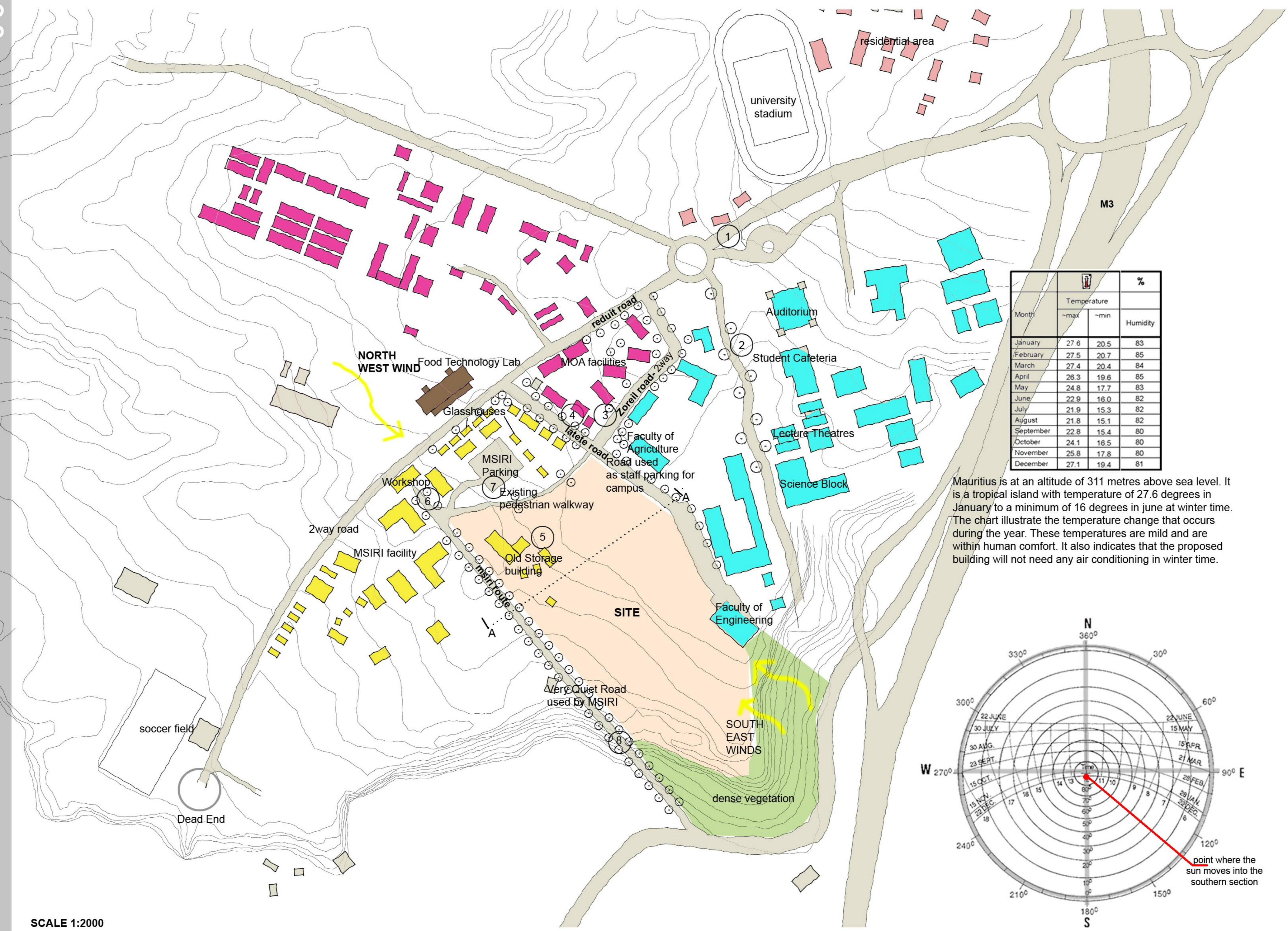
The selected site in the context with the university and MSIRI



View for the Engineering block looking towards Eben

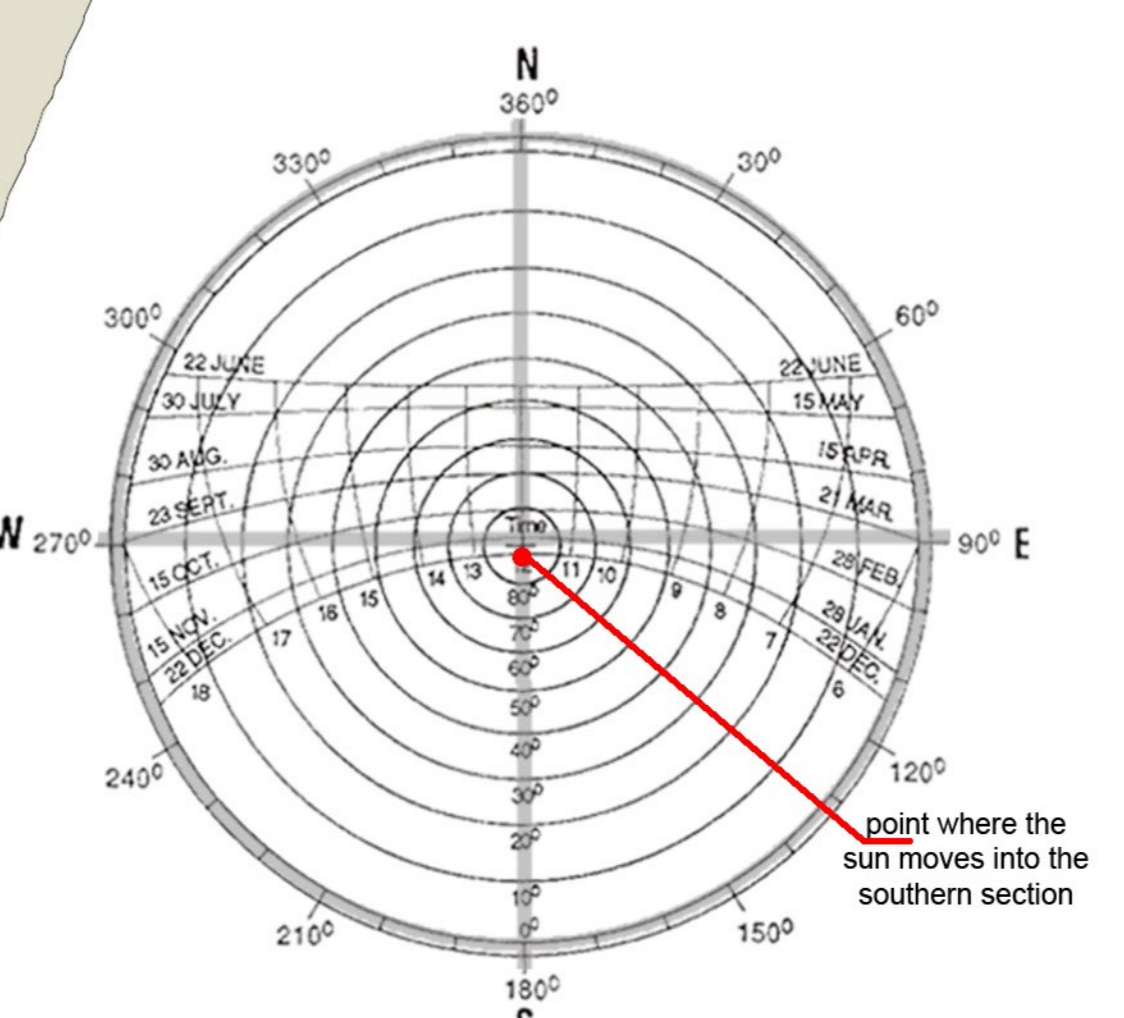


Walkway linking the university to the MSIRI



Month	Temperature		Humidity %
	max	min	
January	27.6	20.5	83
February	27.5	20.7	85
March	27.4	20.4	84
April	26.3	19.6	85
May	24.8	17.7	83
June	22.9	16.0	82
July	21.9	15.3	82
August	21.8	15.1	82
September	22.8	15.4	80
October	24.1	18.5	80
November	26.8	17.8	80
December	27.1	19.4	81

Mauritius is at an altitude of 311 metres above sea level. It is a tropical island with temperature of 27.6 degrees in January to a minimum of 16 degrees in June at winter time. The chart illustrate the temperature change that occurs during the year. These temperatures are mild and are within human comfort. It also indicates that the proposed building will not need any air conditioning in winter time.



The Solar chart diagram indicates the sun movement for Mauritius. It is to be noted that in November/December period, the building will get sunlight on its southern facade as indicated on the diagram.

SCALE 1:2000

The site is in a context with educational and research facilities. The site analysis illustrate a less urbanised area around the site. The university of Mauritius consists between 3 storey high buildings or more; while other sections are between 1-2 storey high. These are mostly pitched roofs.



1. Bus stop on Reduit Road



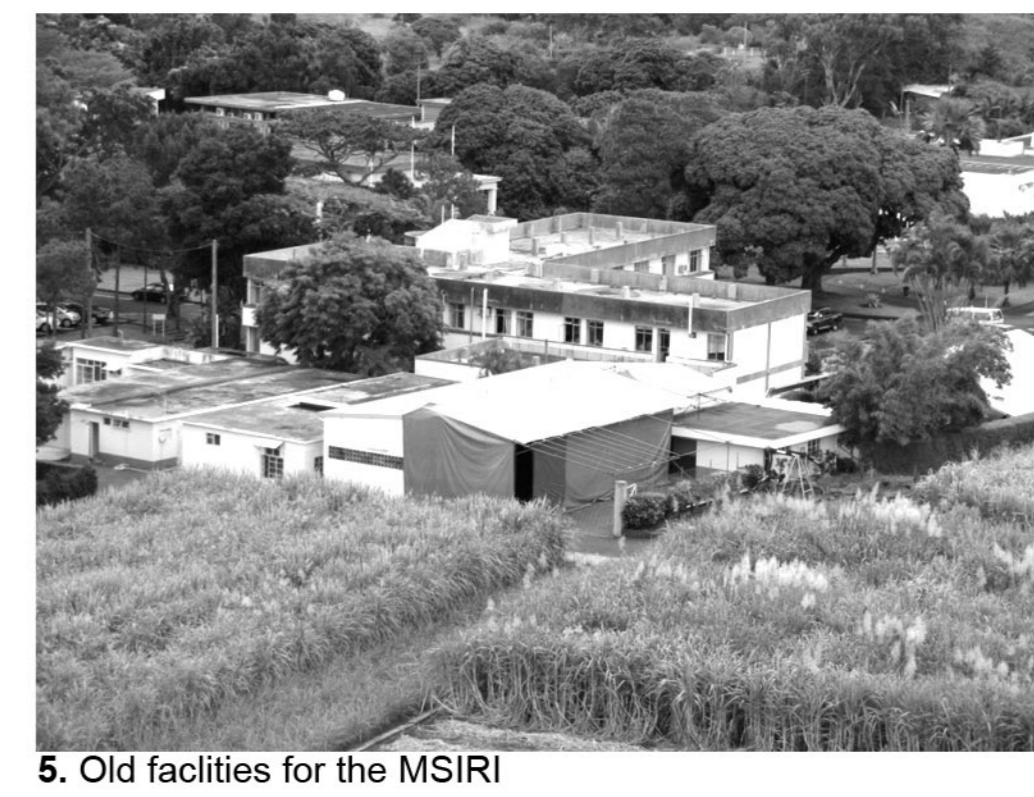
2. The main entry to University of Mauritius



3. Two storey buildings for the MOA on Zoreil Road



4. Greenery along MOA facilities in Latete Street



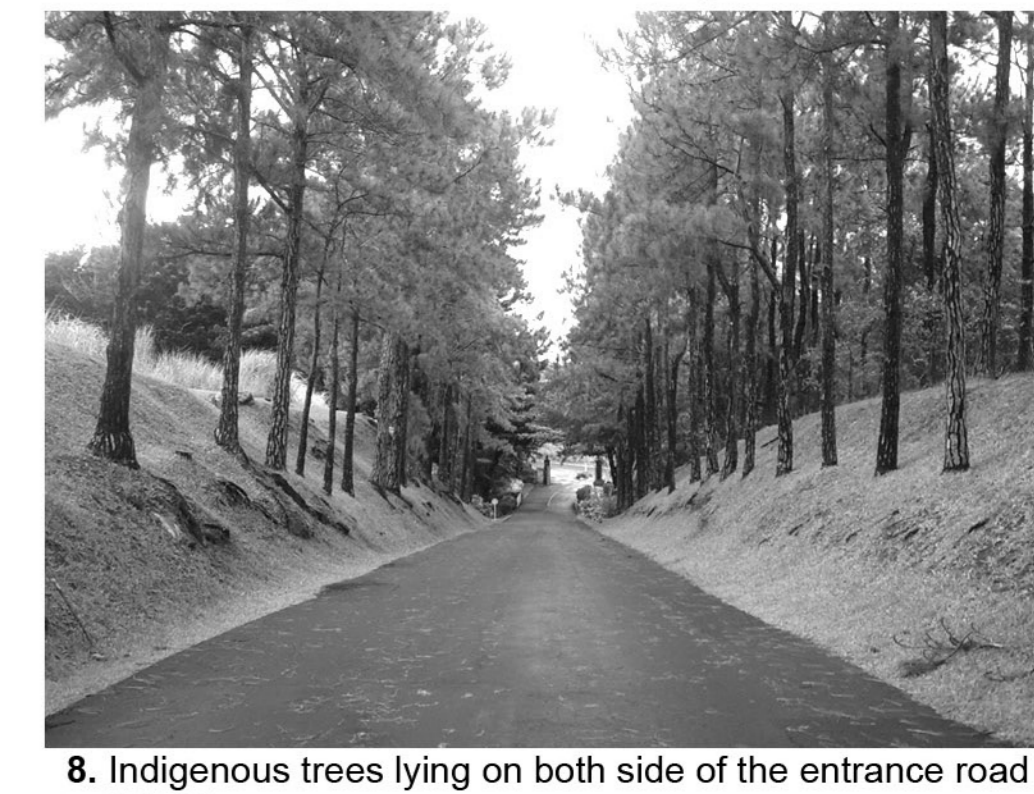
5. Old facilities for the MSIRI



6. Road ending with a research building for the MSIRI



7. Greenhouses that are not visited on a daily basis



8. Indigenous trees lying on both side of the entrance road to MSIRI

analytical study



localising the precincts
The precincts neighbouring Reduit are Eben and Moka. Eben being a newly developed area with major office buildings and commercial facilities and Moka being an educational and cultural area. Reduit is more focused with educational and research devoted precinct.

road linkages
The figure highlights the routes in the area. The highway (M3) diverges to Eben, Reduit and Moka. Reduit road doesn't link to Eben- it is a dead-end

boundaries
The university extend to the MOA and research facilities. A feeding route for vehicular access used by university staff members and MOA staff demarkate the university boundary.

vehicular routes and noise
The roads surrounding the site is highlighted. The major noise is from the M3. Dense vegetation reduce the amount of noise and acts as a wind barrier. The MSIRI route is generally calm as it feeds only the MSIRI facilities. Due to the vehicular movement from Latete road, it is generally noisy.

Transport routes
Bus transport route is as indicated. Due to the dead end on Reduit road, the buses are not able to feed to Eben. They have to do a U-Turn facilitated by a round-about to go back to the highway. From there, it feeds back to other parts of the island. There is a need for a new urban proposal. Such proposal should take into consideration the transport route of buses that would facilitate the movement of people working in the region.

Vegetation
The precincts are in an agricultural area. Dense forestations, courtyard spaces and a river lies in the vicinity. Due to the climatic condition of Mauritius, courtyard spaces are extremely useful, allowing circulation of cool/warm air. The use of courtyard would therefore facilitate conducive working environment in the new proposed facility.

design primer

linking precincts

contineous development improving transport routes

Macro- Micro Analysis

research community

orientation

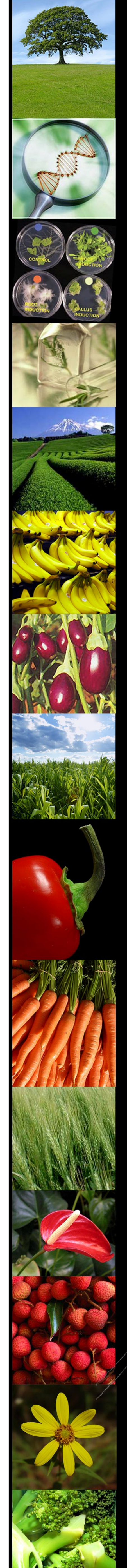
sustainability

collecting rain water and using sun as an energy resource

pedestrian walkway

landscaping

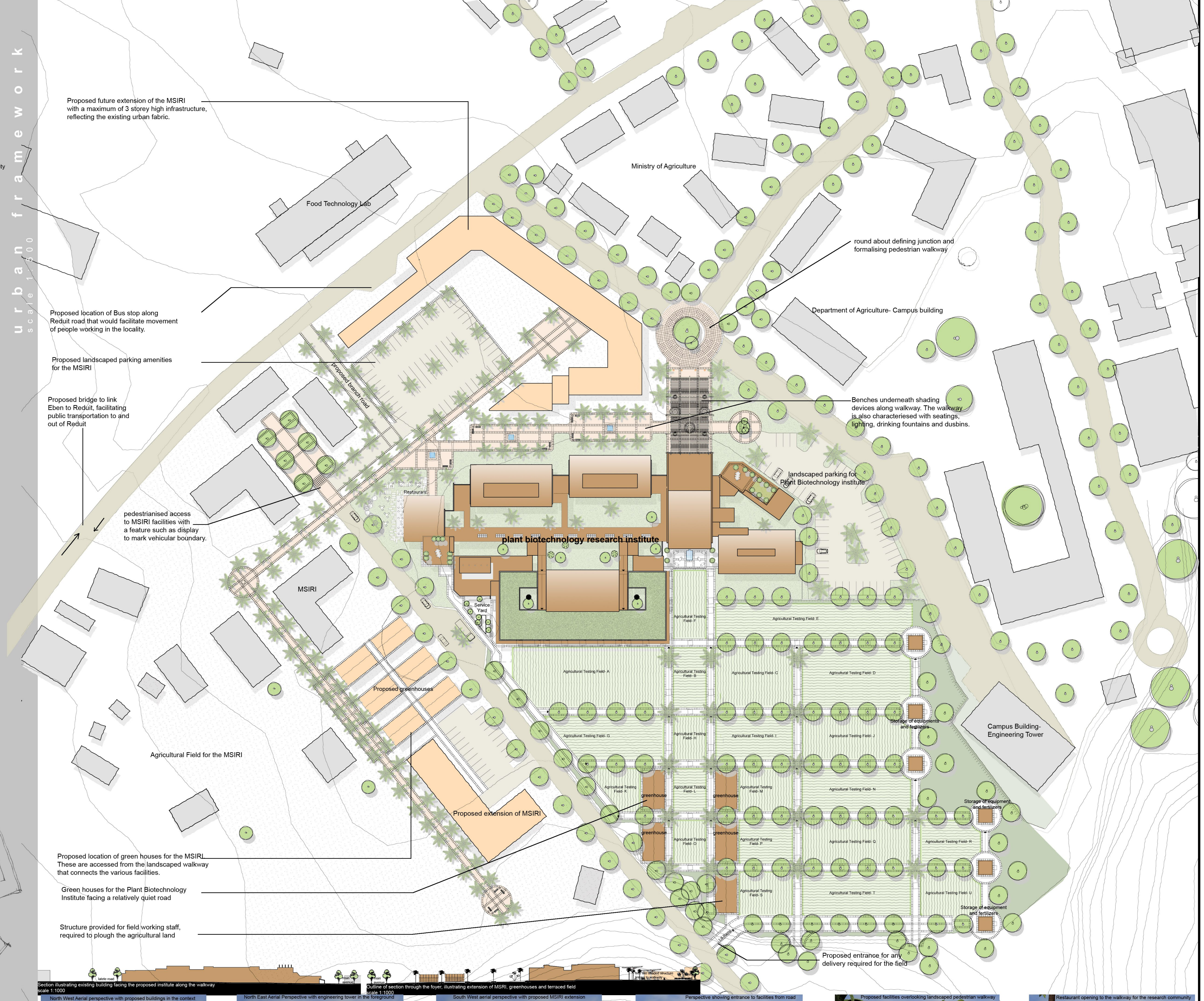
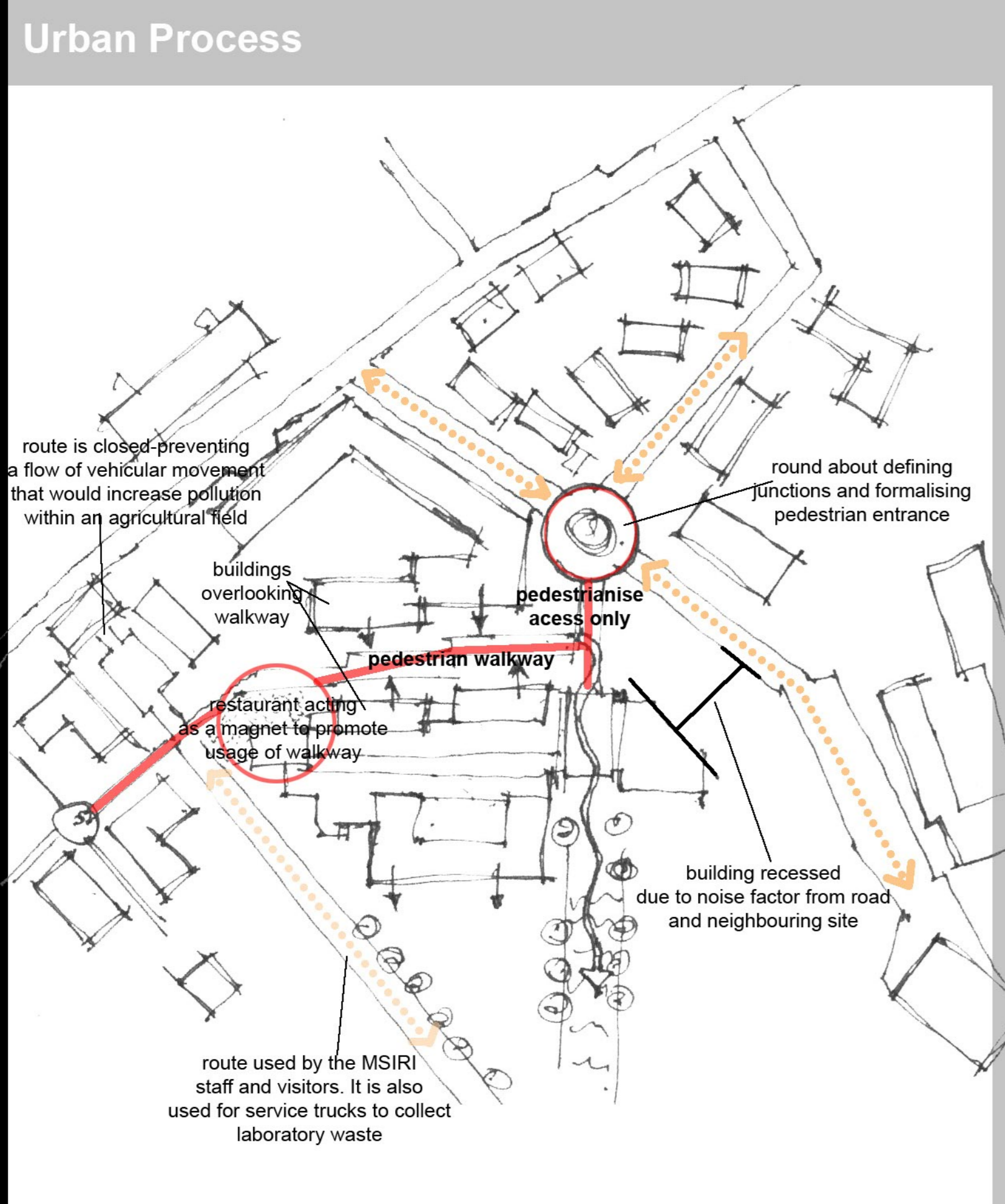
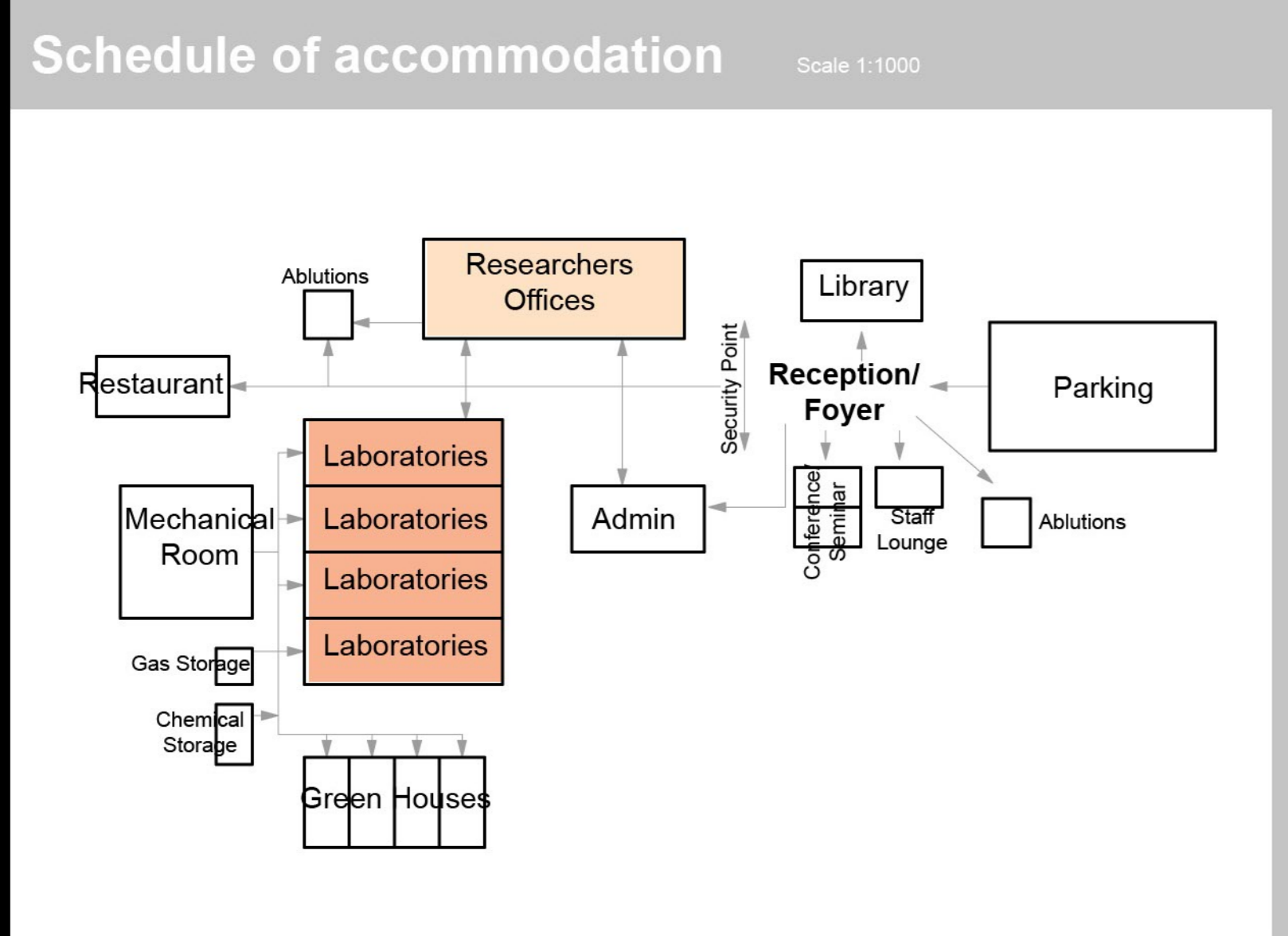
materials



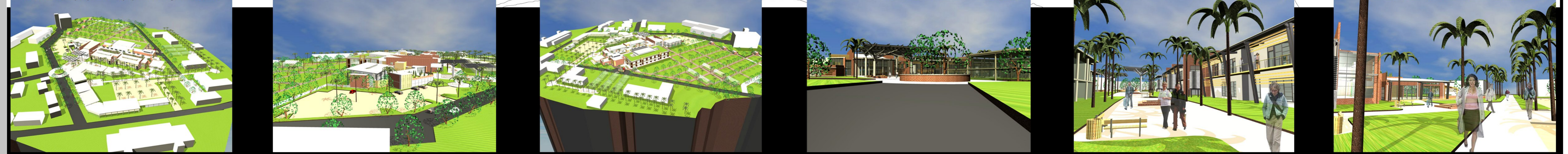
a new plant biotechnology institute for mauritius

Footprint study

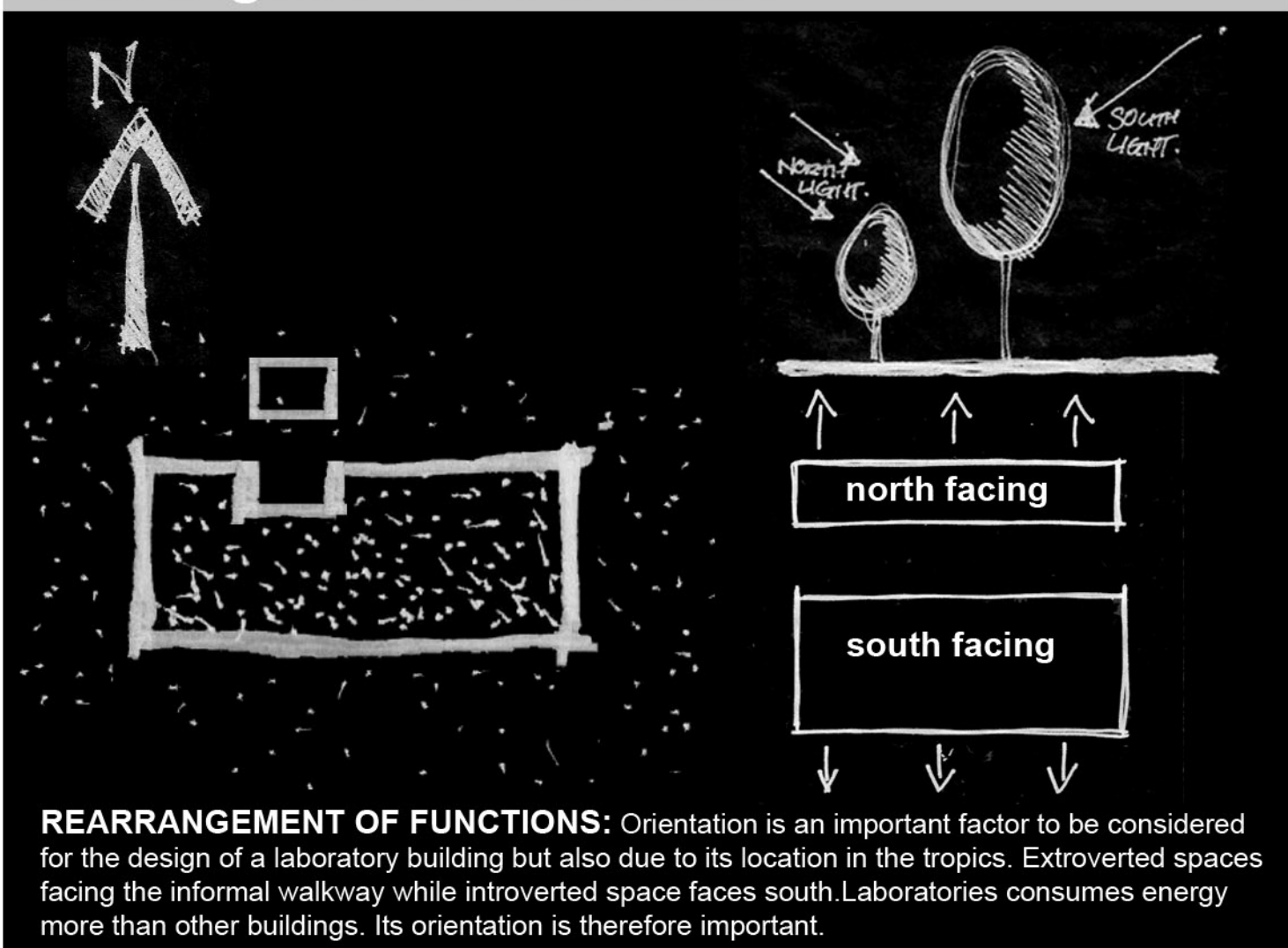
- Parallel elements- Walkway v/s Concourse
Walkway not fully utilised
North West- South East Orientation
- Offices opening up to courtyard spaces
Accessibility from lab to field
Building as a boundary to walkway
Offices are extracted from lab. space
- Laboratory spaces being separated reduces flexibility
Offices are separated onto each laboratory blocks- no common/central interaction space
- Accessibility to field from lab
separation of spaces- offices and laboratories
Labs are exposed to the walkway on ground floor
- building is not exposed to the walkway
site not fully utilised
- Separation of spaces- labs and offices
internal courtyards within office component
Entrance exposed to the corner



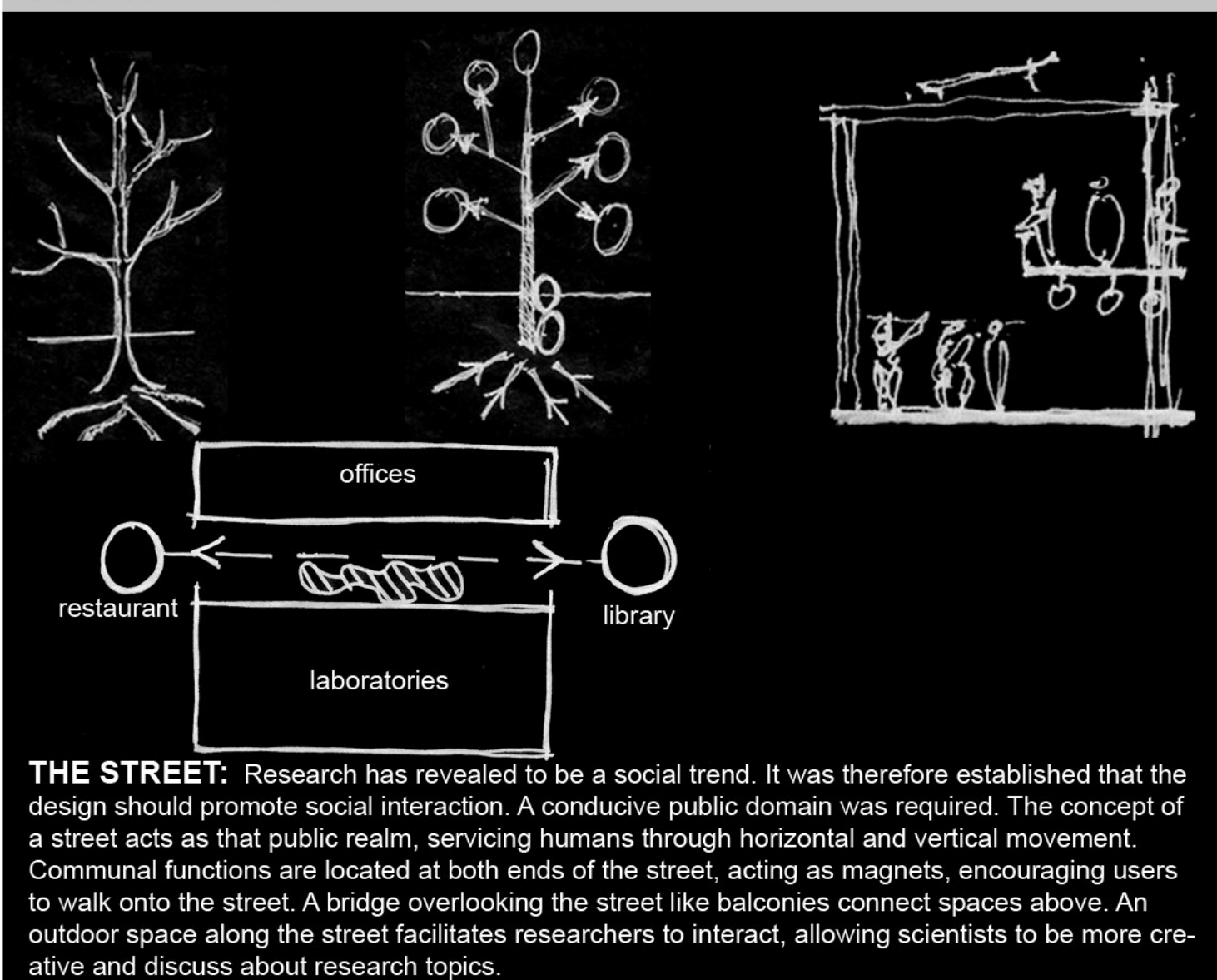
Section illustrating existing building facing the proposed institute along the walkway scale 1:1000
 Outline of section through the foyer, illustrating extension of MSIRI, greenhouses and terraced field scale 1:1000



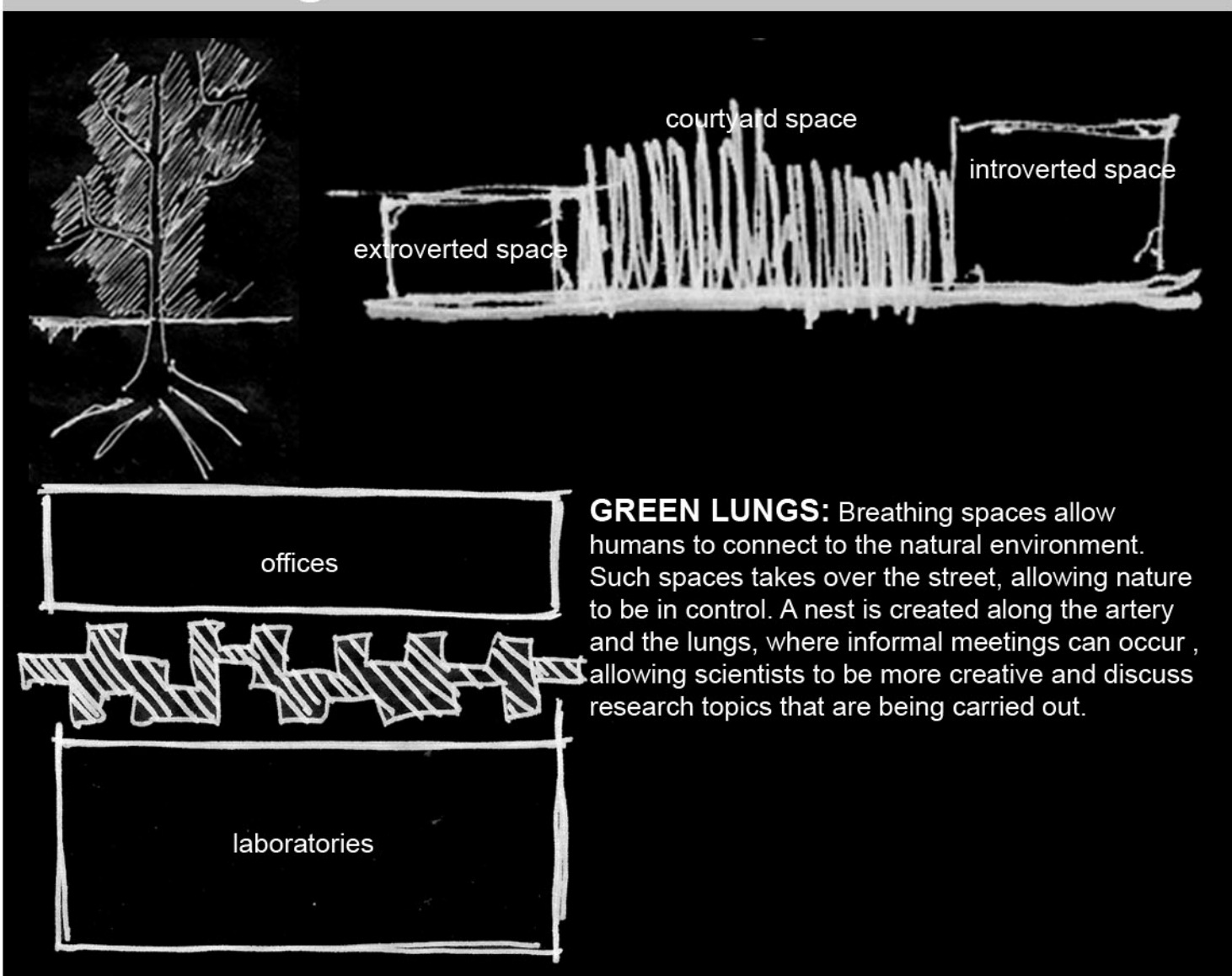
Rearrangement of Functions



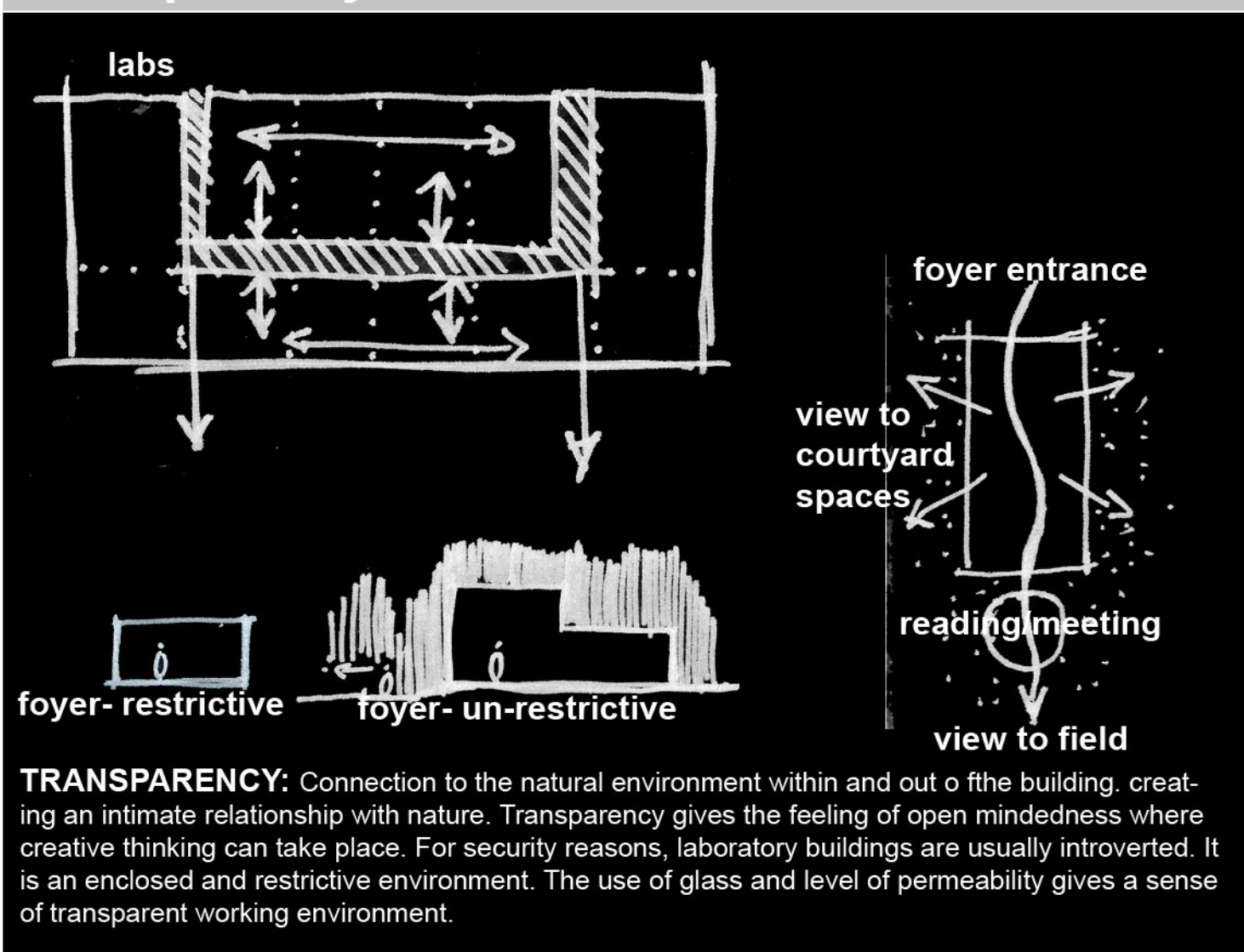
The Street



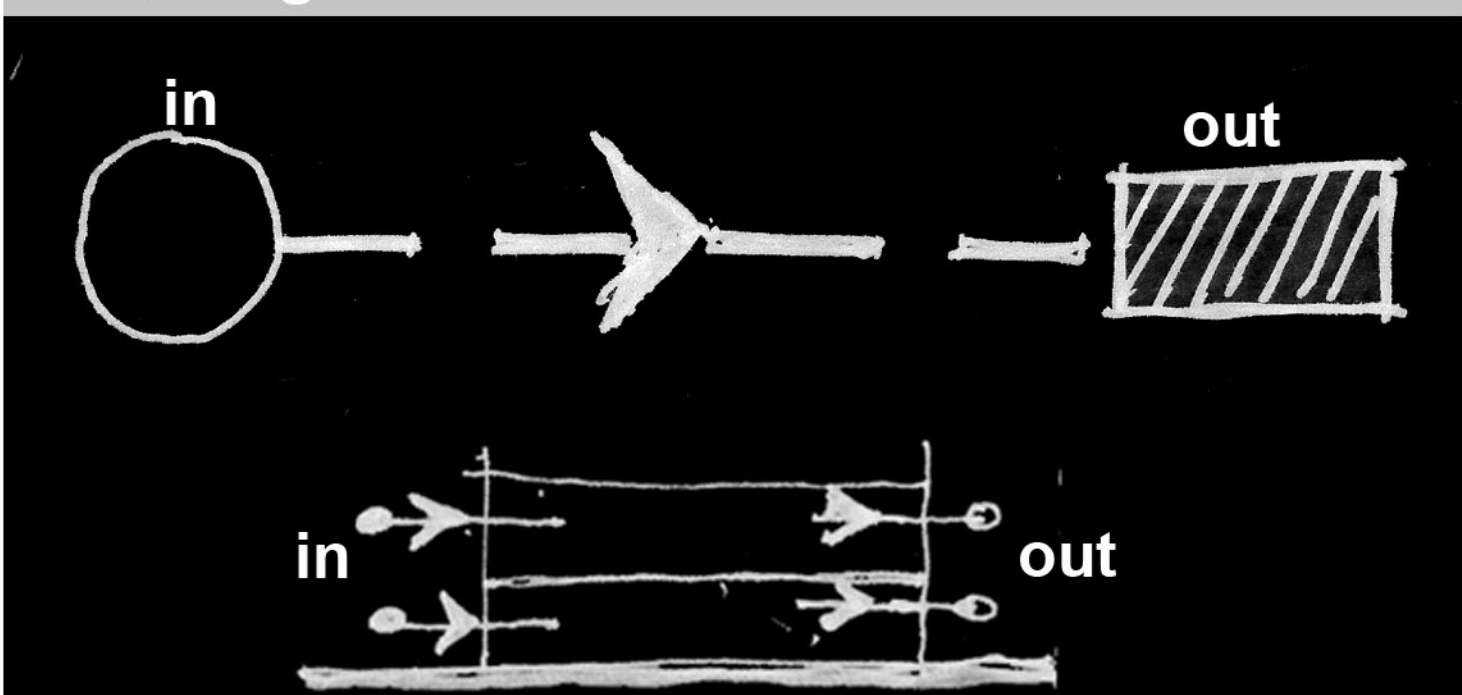
Green Lungs



Transparency



Servicing



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design concepts

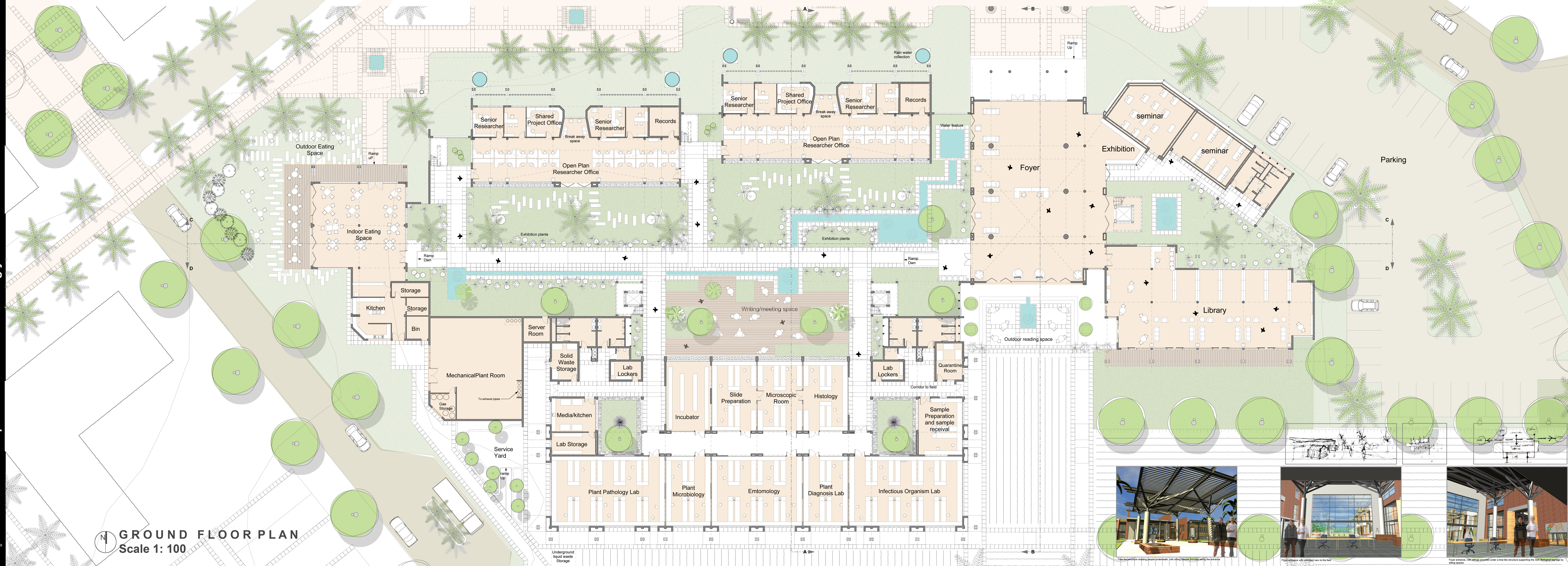
DISSERTATION 2009
by afzal soobrattee



a new plant biotechnology institute for mauritius

plan

DISSERTATION 2009
by afzal soobrattee



GROUND FLOOR PLAN
Scale 1: 100



These skybridges shelter people underneath, with sitting spaces provided along the entrance

Open-plan office with unobstructed view to the field

Foyer entrance, with seating provided under a tree-like structure supporting the roof. Biological supplies by sitting spaces.

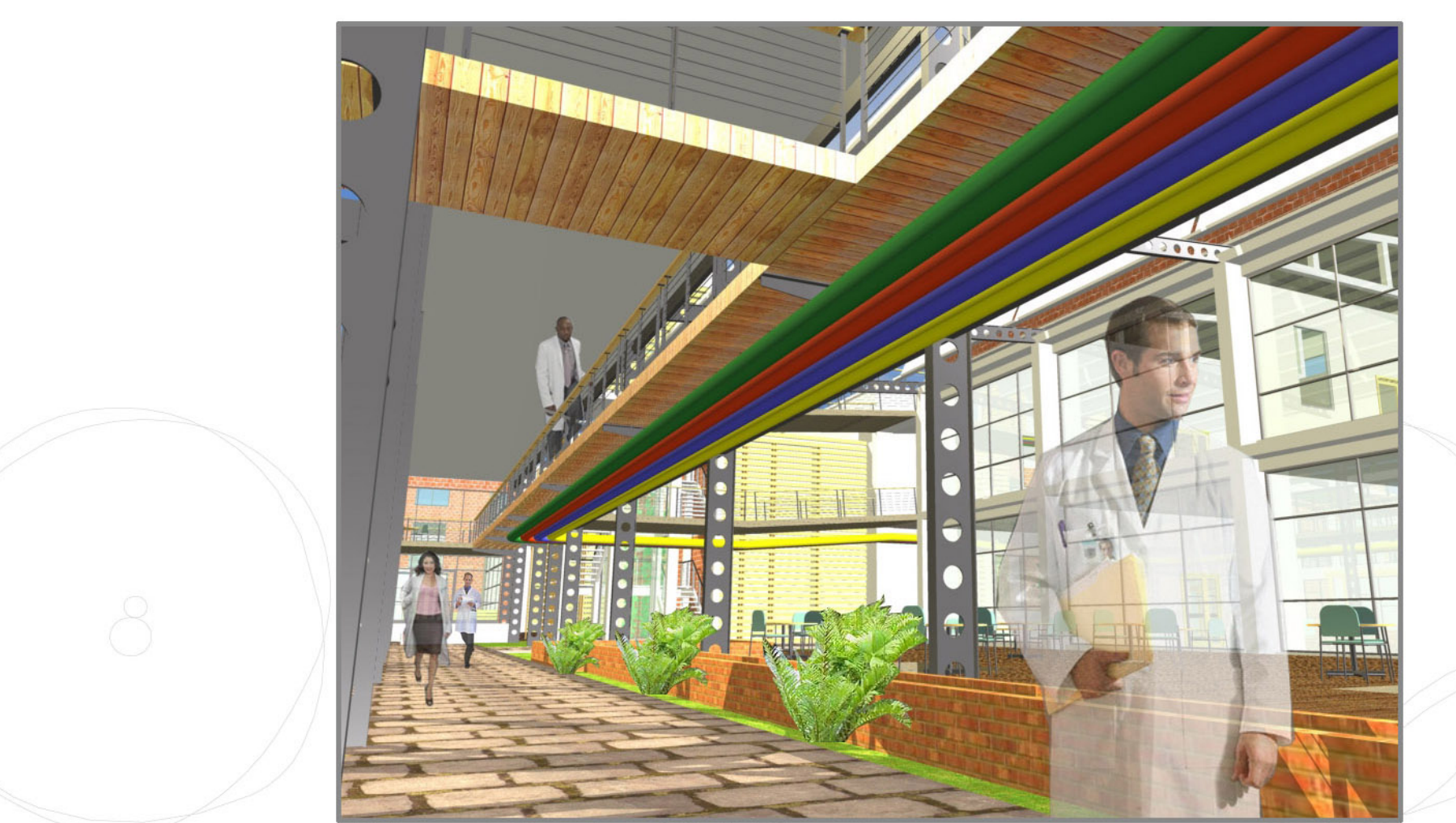
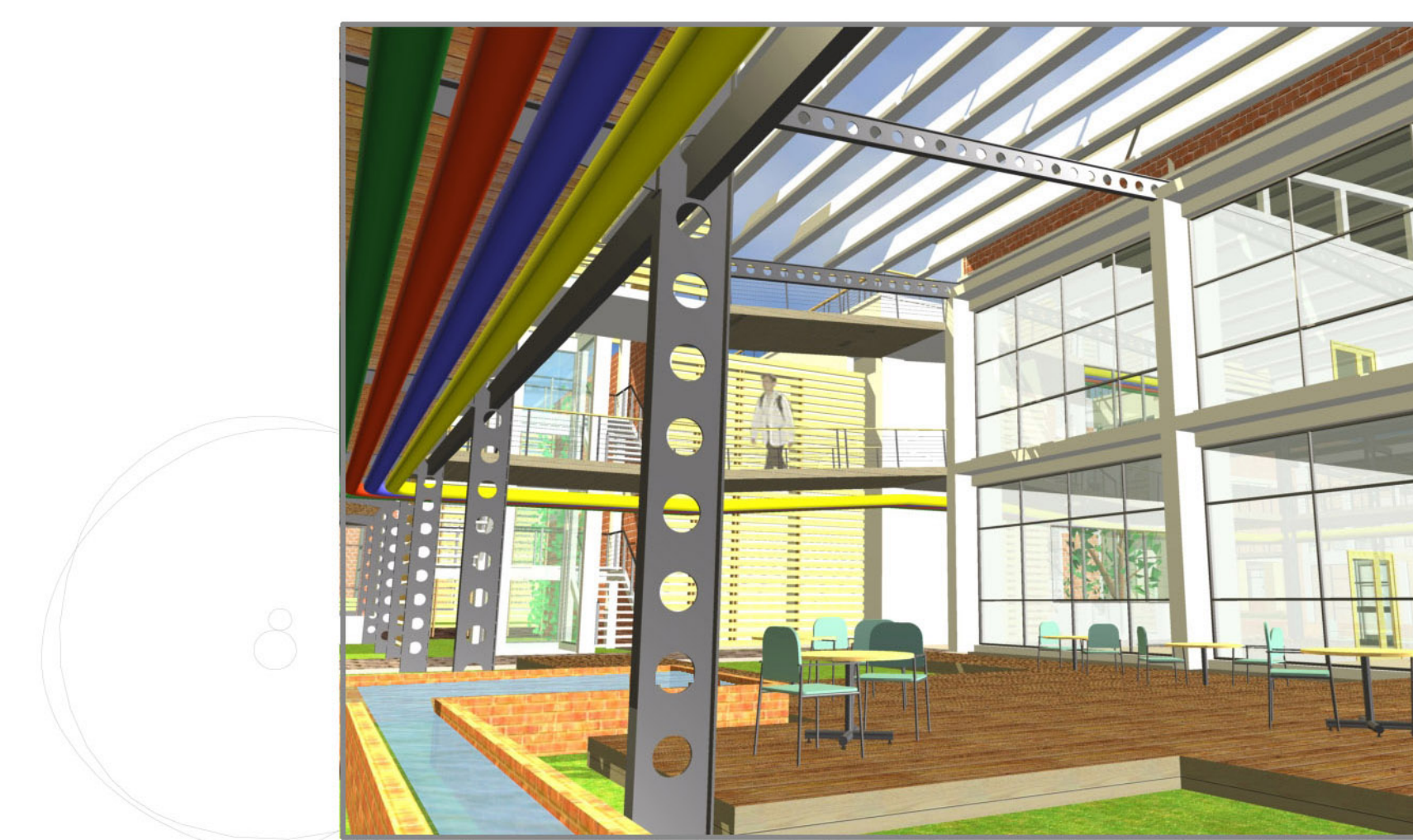
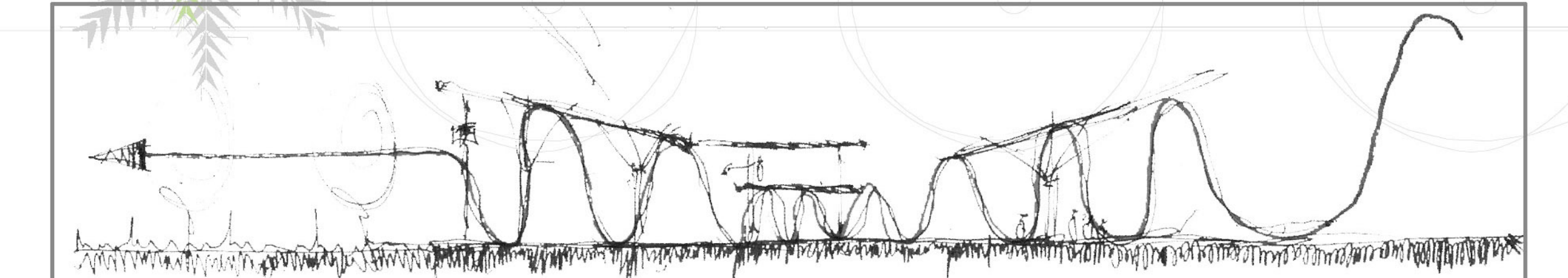
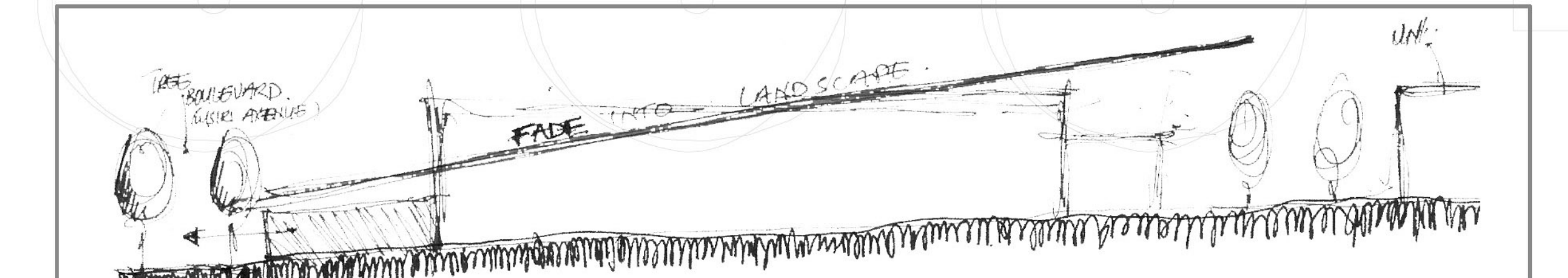


a new plant biotechnology institute for mauritius

plan

DISSERTATION 2009
by AFAI SPOURDINE

FIRST FLOOR PLAN
Scale 1: 100



A street with bridges overlooking the walkway and courtyard spaces

Windowing space facing laboratories and walkway, encouraging scientists towards formal/informal discussions

Walkway overlooking writing space in the background



a new plant biotechnology institute for mauritius



NORTH ELEVATIONS
Scale 1: 100



SOUTH ELEVATION
Scale 1: 100



a new plant biotechnology institute for mauritius



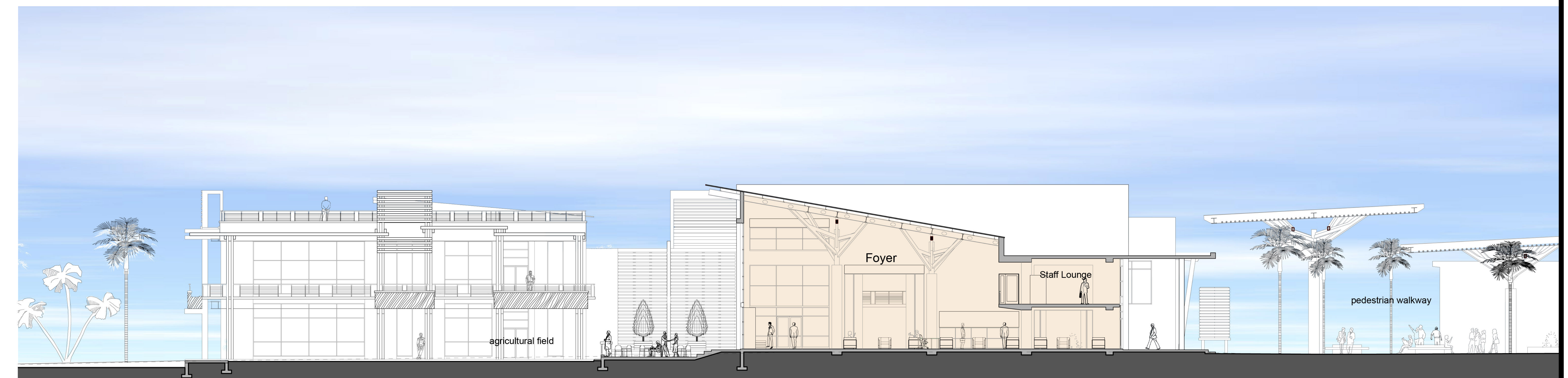
EAST ELEVATION
Scale : 100



SECTION A - A
Scale 1: 100



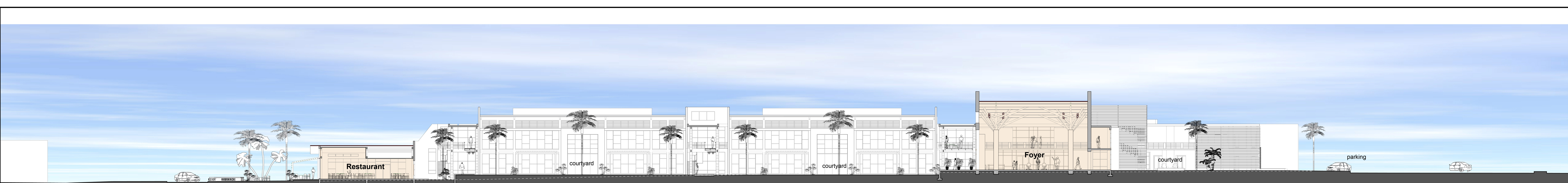
WEST ELEVATION
Scale 1: 100



SECTION B - B
Scale 1: 100



a new plant biotechnology institute for mauritius



SECTIONAL ELEVATION C - C
Scale 1 : 100

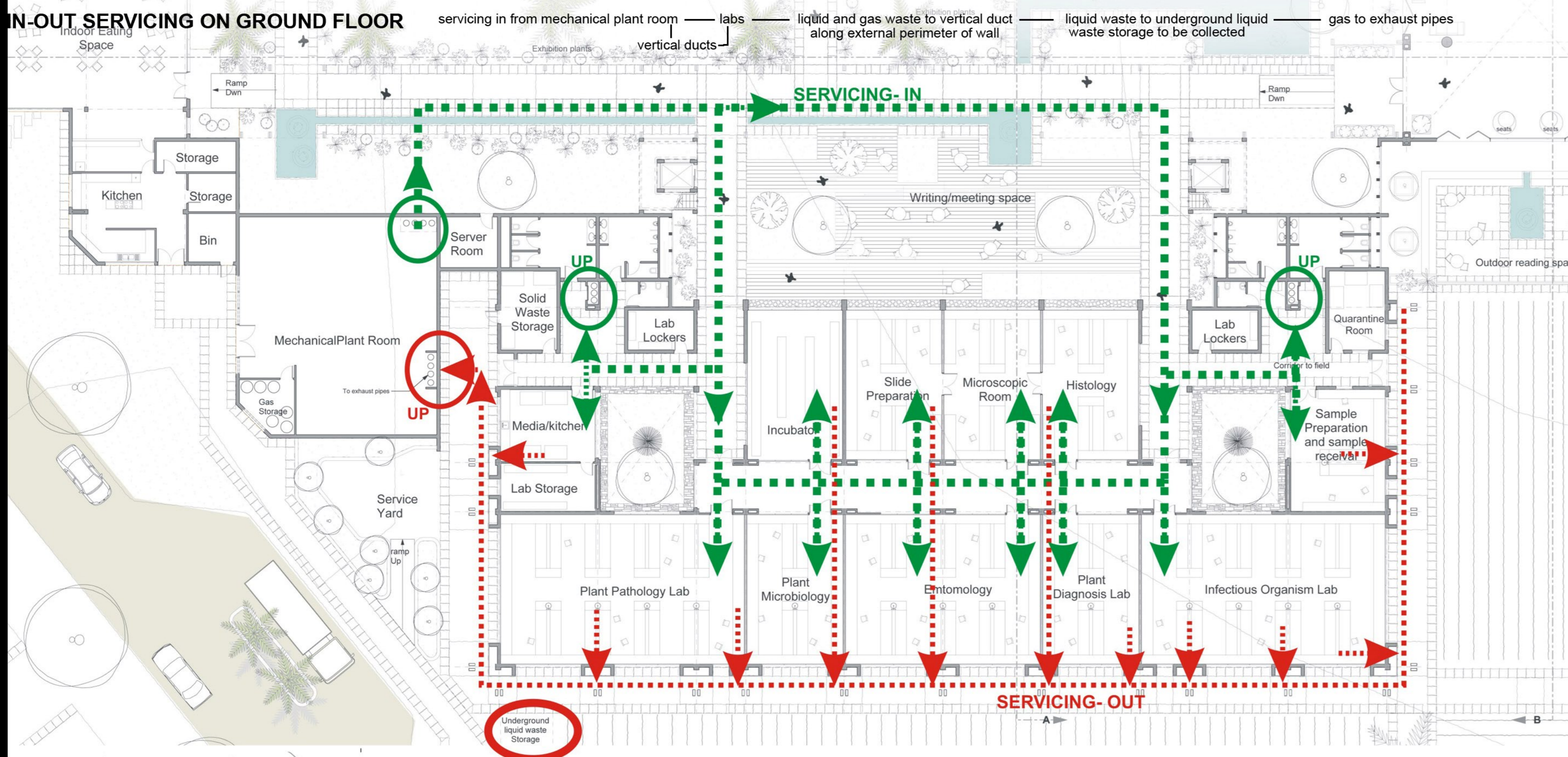
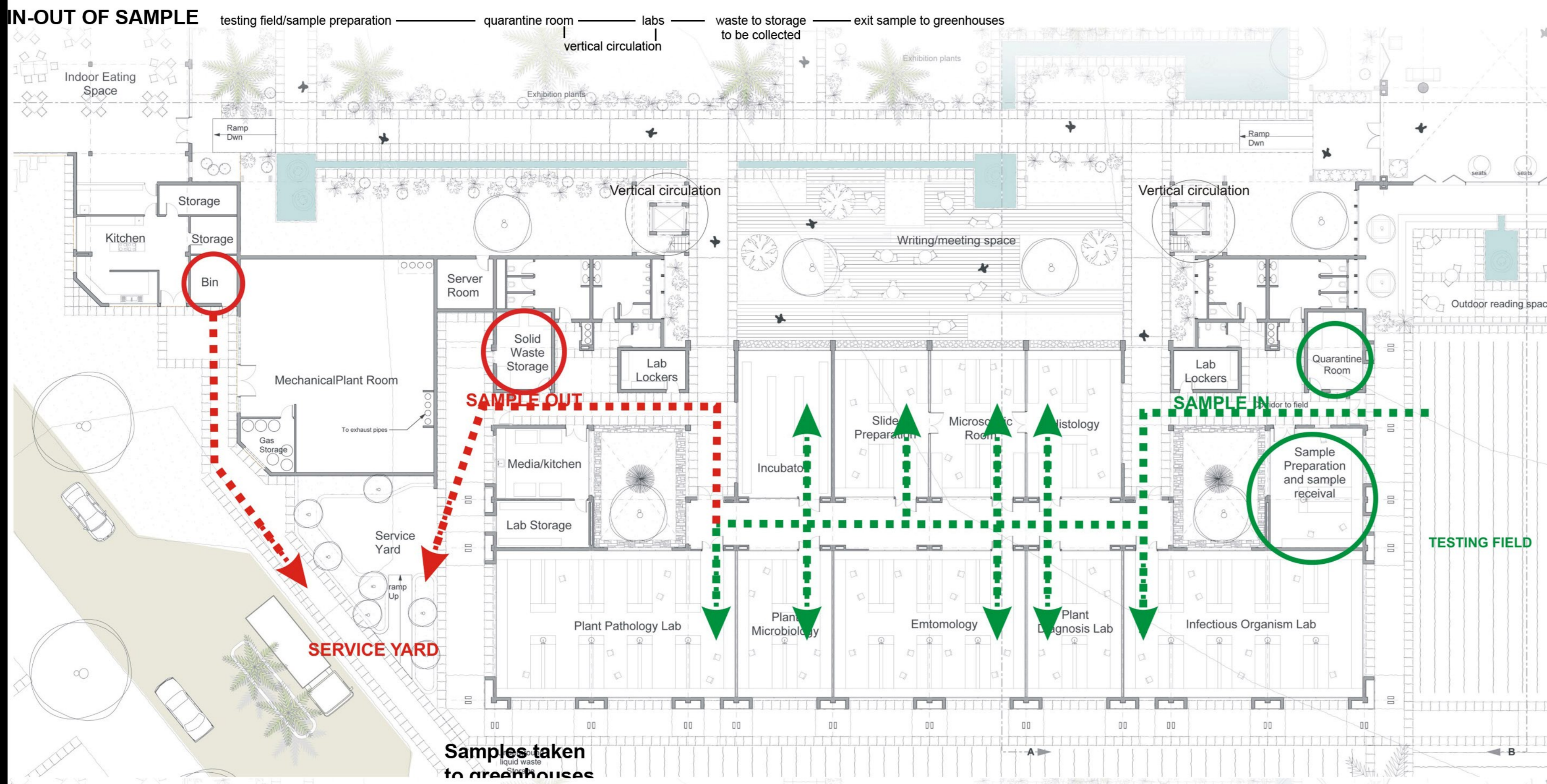


SECTIONAL ELEVATION D - D
Scale 1 : 100

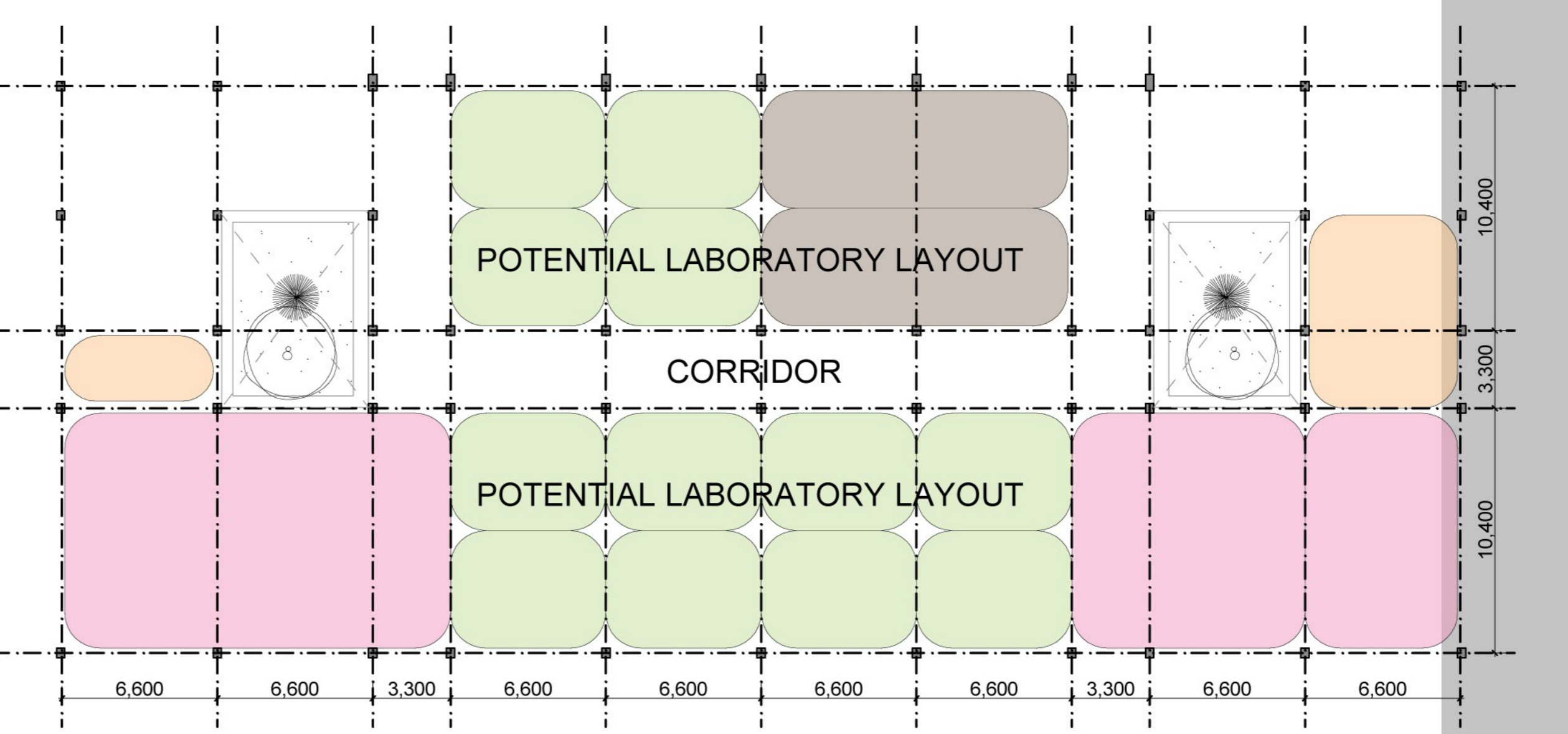
sectional elevations

DISSERTATION 2009
by afzal soobrattee

a new plant biotechnology institute for mauritius



POTENTIAL LABORATORY DIVISION



SUSTAINABLE APPROACH

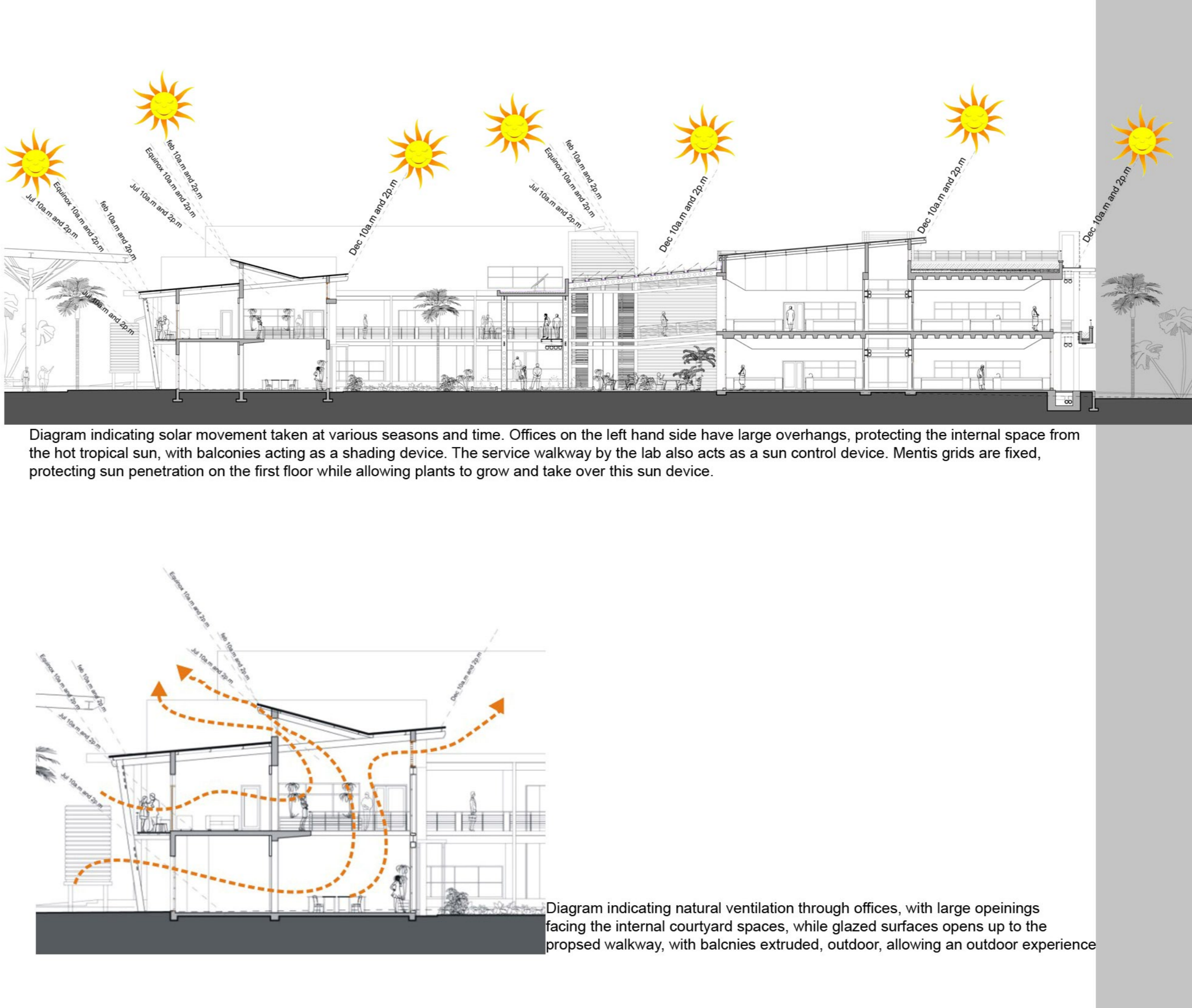
Orientation
With the laboratories facing south, the thermal mass gained on that section is reduced. A roof garden is located above a portion of the laboratories; this not only is used as an experimental roof garden but also improves the thermal mass reduction of the building. Extroverted spaces open to the north and the walkway, allowing natural light and ventilation to flow in. The institute is located in a tropical island. The sun is expected to be harsher compared to Durban. Large overhangs are used to reduce sun penetration.

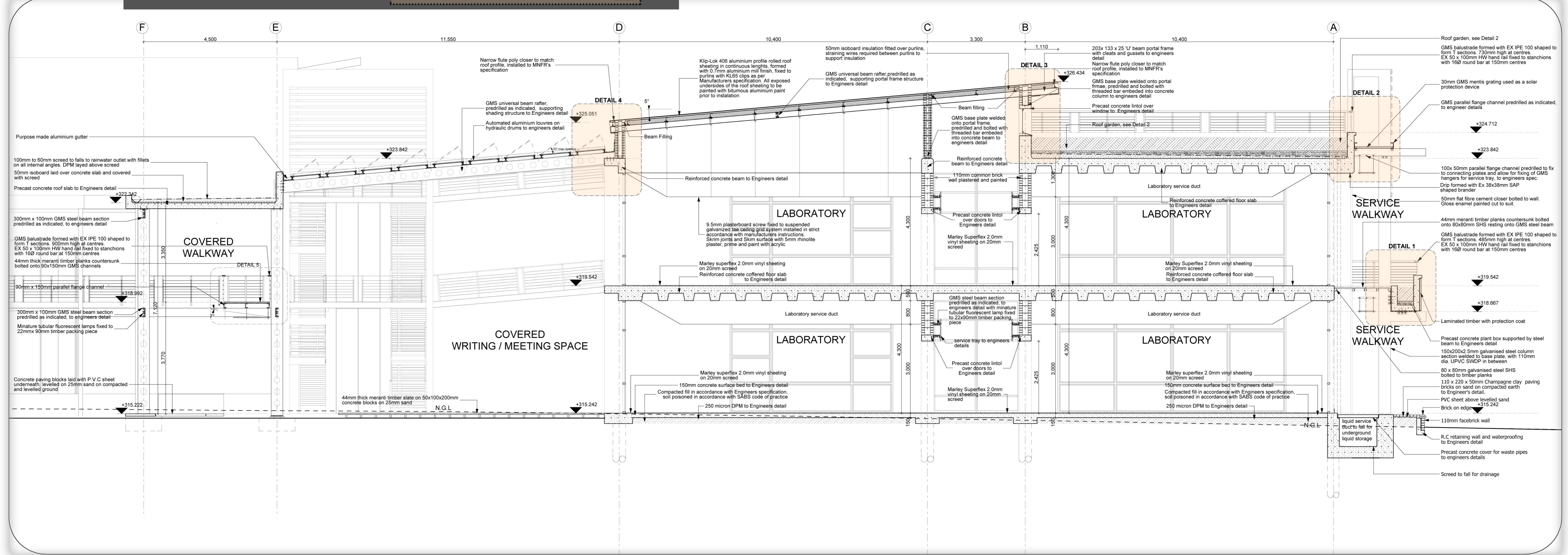
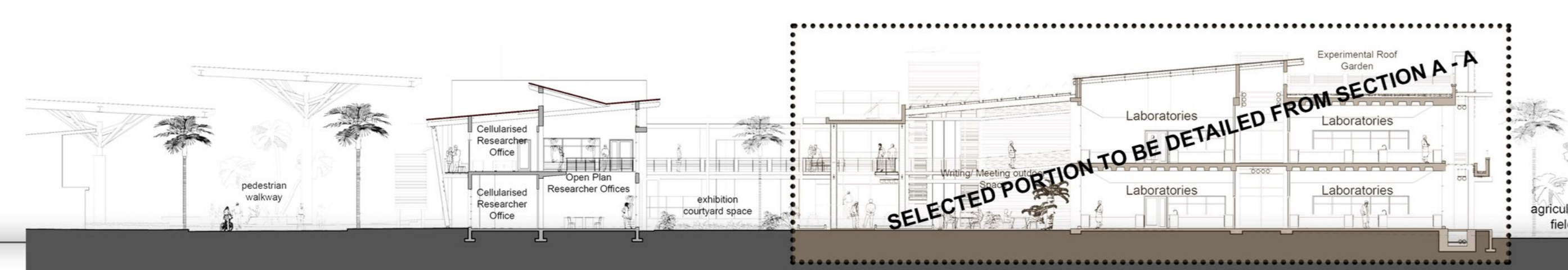
Rain water collection
Harvesting of natural resources such as rainwater will be consumed. Such resource will be used to water the plants and other means. This will reduce water consumption by the institute.

Photovoltaic Panels
Photovoltaic panels are used to generate electrical energy to be consumed by the institute. This will be consumed in offices, seminar rooms and library. Electricity from the municipal line will be used in the laboratories. These are high consumable of energy and the energy generated by the photovoltaic panels will not be sufficient for the labs.

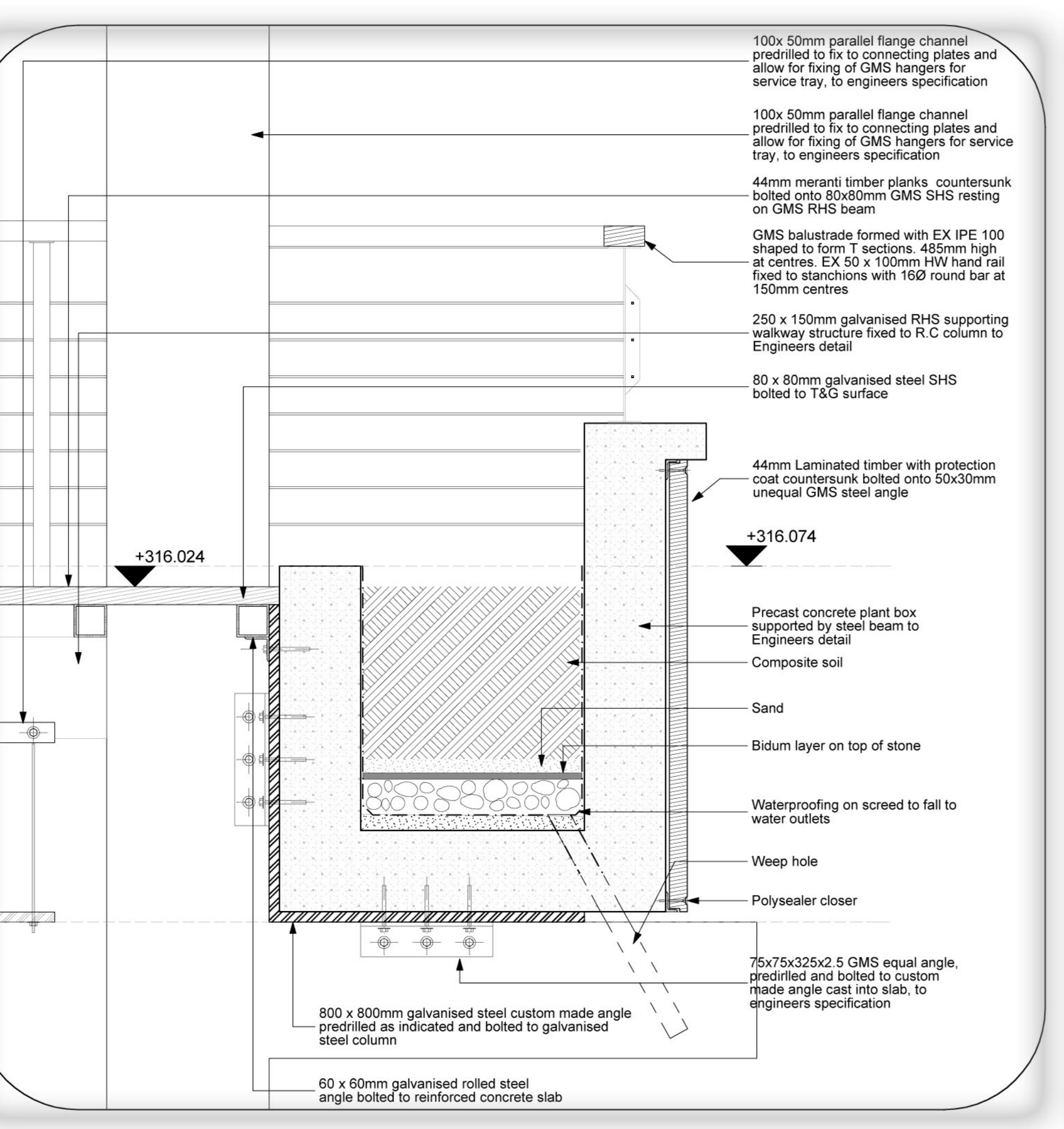
Materials
The use of brick infill compared to concrete blocks is preferable. Compared to concrete blocks, bricks have a low thermal mass.

SUN STUDY & AIR MOVEMENT

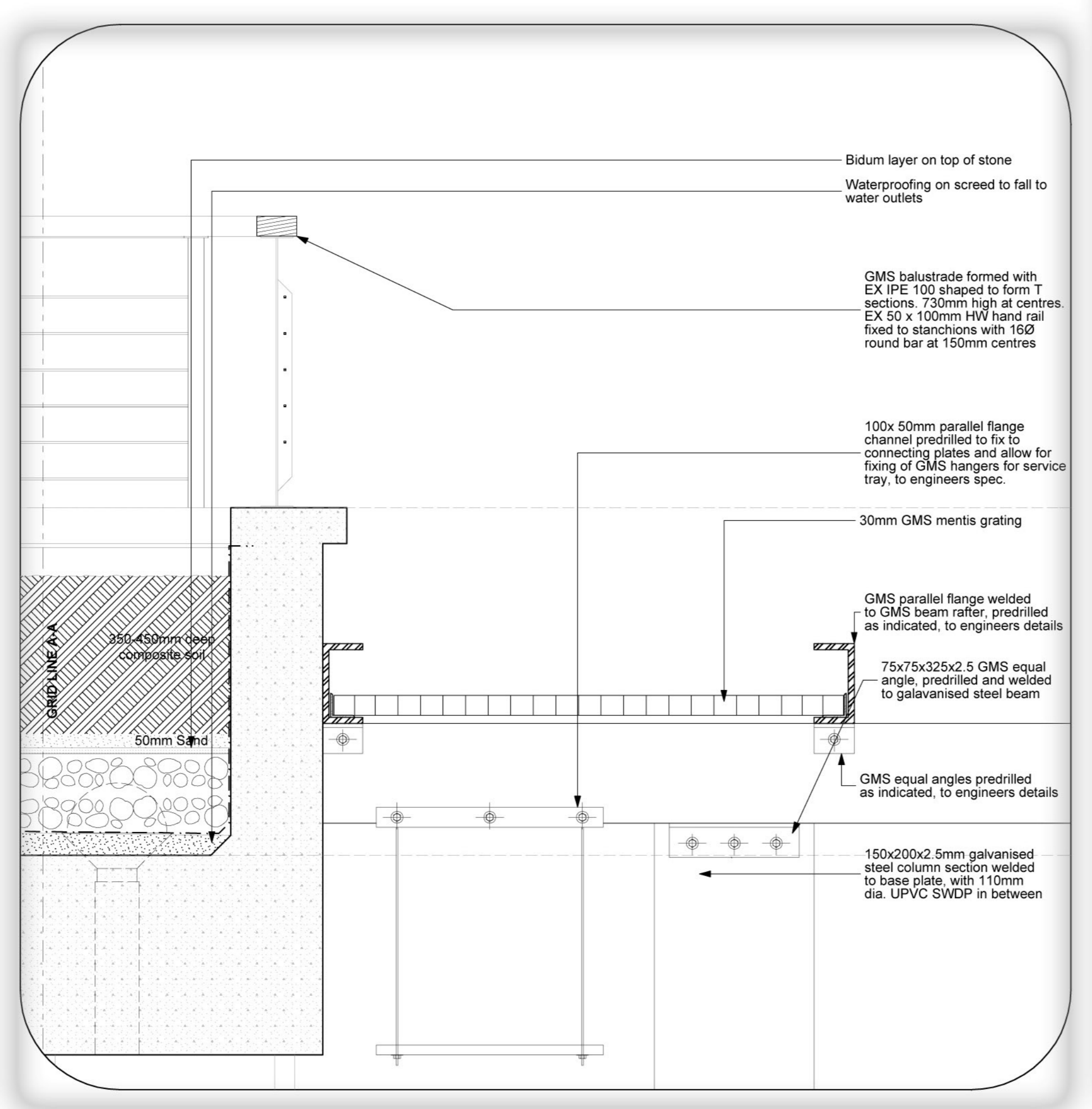




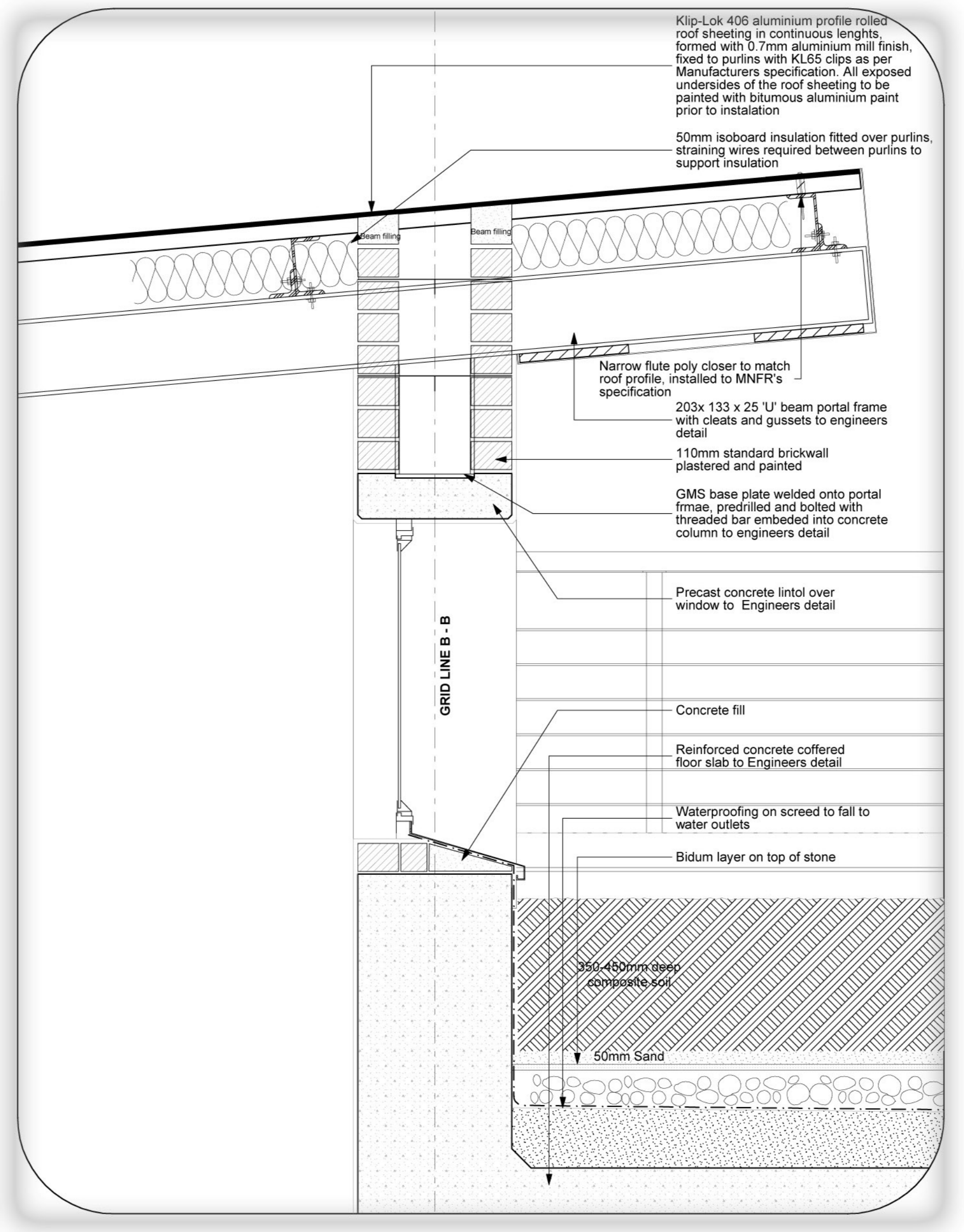
PARTIAL TECHNICAL SECTION A-A
scale 1:50



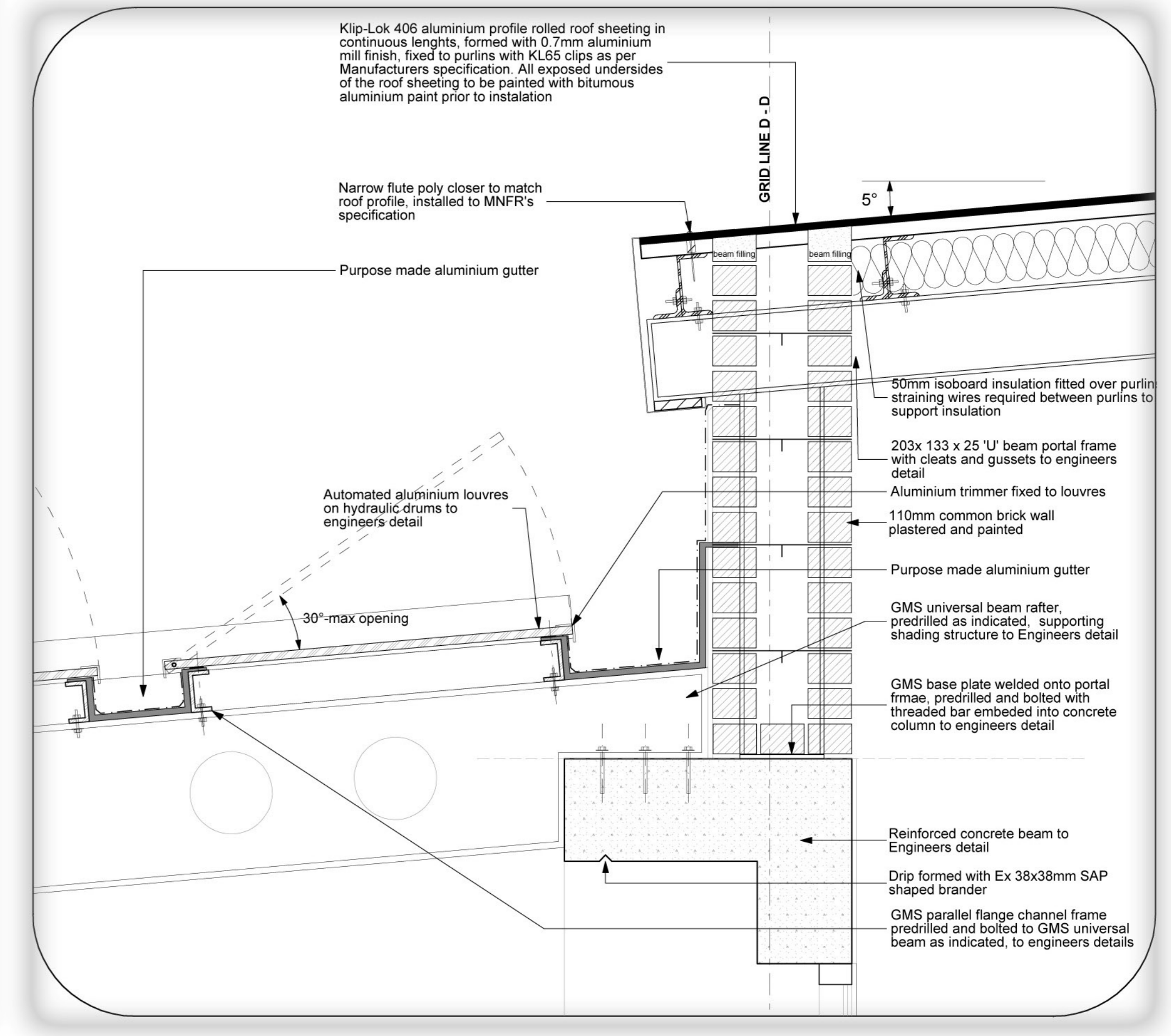
DETAIL 1
scale 1:10



DETAIL 2
scale 1:10



DETAIL 3
scale 1:10



DETAIL 4
scale 1:10



Note

Presentation drawing number: 1, 2, 3, 10 and 11 are at A0 size paper (1189x841mm).

Presentation drawing number: 5, 6, 7, 8 and 9 are at 2378x841mm paper size.