

---

**The design of a new Cancer Research  
Institute and Laboratories for Durban**

Louis Stephen du Plessis

A dissertation submitted to the School of Architecture, Housing and Planning – University of KwaZulu-Natal, Howard College Campus, in partial fulfilment towards the degree of Master of Architecture.

January 2008


---

---

## Declaration

Submitted in partial fulfilment of the requirements for the degree of Masters of Architecture, in the Graduate Programme in Architecture, University of KwaZulu-Natal, Durban, South Africa.

I declare that this dissertation is my own unaided work. All citations, references and borrowed ideas have been duly acknowledged. It is being submitted for the degree of Masters of Architecture in the Faculty of Humanities, Development and Social Science, University of KwaZulu-Natal, Durban, South Africa. None of the present work has been submitted previously for any degree or examination in any other university.



---

Louis Stephen du Plessis

21<sup>st</sup> January 2008

---

---

## Dedication

This work is dedicated in fond memory of Beryl Sutherland Willetts, my great-aunt.

Dearest Aunty B, I miss our Saturday morning teas, the games of scrabble and the words of wisdom, guidance and comfort. My first two years at university were made that much easier to cope with looking forward to our regular weekend get-togethers. You were a true lady, though and through. You showed such grace, strength and faith in Christ, especially towards the end. You were a great role model that I hope to emulate in my years to come.

"Lost in pastures green abiding, safely with the Shepherd rest."

*J.S. Bach – 'Sheep may safely graze', from Cantata No. 208*

---

---

## **Contents**

<b>Acknowledgements .....</b>	<b>i</b>
<b>Abstract.....</b>	<b>ii</b>
<b>Introduction .....</b>	<b>iii</b>
<b>Chapter 1 – Research Background .....</b>	<b>1</b>
1.1 Background to laboratory design .....	1
1.2 Background to cancer research .....	1
1.3 Background to facility.....	2
1.4 Research problem .....	3
1.4.1 Design response .....	3
1.4.2 Building brief paradox .....	3
1.5 Key questions .....	4
1.6 Working hypothesis .....	4
1.7 Aims and objectives of the study .....	4
1.8 Conclusion.....	5
<b>Chapter 2 – Research Methodology .....</b>	<b>6</b>
2.1 Introduction.....	6
2.2 Research plan .....	6
2.3 Secondary data.....	7
2.4 Primary data .....	8
2.5 Data synthesis .....	9
2.6 Conclusions.....	9
<b>Chapter 3 – Literature Review and Theoretical Framework.....</b>	<b>11</b>
3.1 Introduction.....	11
3.2 Literature review.....	11
3.2.1 Evolution and current issues of the laboratory environment .....	11
3.2.2 The need for prioritising the human process.....	13
3.2.3 The architectural expression of research environments: sculpture versus services .....	14
3.3 Theoretical framework .....	15
3.3.1 Research as a social phenomenon .....	15
3.3.2 The impact that management structures have on research environments.....	16
3.3.3 The impact of Power-Knowledge on the design of research environments.....	16
3.3.4 An environment for social interaction.....	17
3.3.5 The 'Internal Street' as a device for a social environment .....	19

---

---

3.4 Conclusions .....	21
<b>Chapter 4 – Precedent Studies .....</b>	<b>22</b>
4.1 Introduction.....	22
4.2 Schlumberger Cambridge Research Ltd.....	23
4.2.1 Background.....	24
4.2.2 Client's brief.....	24
4.2.3 Planning resolution.....	24
4.2.4 Imagery and narrative .....	25
4.2.5 Service approach .....	26
4.2.6 Environmental impact reduction .....	26
4.2.7 Conclusions .....	27
4.3 The Salk Institute for Biological Sciences .....	28
4.3.1 Background.....	28
4.3.2 Client's brief.....	28
4.3.3 Treatment of spaces.....	30
4.3.4 Planning resolution.....	30
4.3.5 Service approach .....	31
4.3.6 Structural system.....	32
4.3.7 The metaphysical aspects.....	32
4.3.8 Conclusions .....	33
4.4 The Neurosciences Institute .....	34
4.4.1 Background.....	34
4.4.2 Client's brief.....	34
4.4.3 Design elements .....	35
4.4.4 Planning resolution.....	35
4.4.5 Courtyard comparison.....	35
4.4.6 Materials.....	36
4.4.6 Conclusions .....	36
4.5 Extension to The Salk Institute.....	37
4.5.1 Background.....	37
4.5.2 Planning resolution.....	38
4.5.3 Functional flaws .....	38
4.5.4 Conclusions .....	39
4.6 Overall conclusions drawn from precedent studies .....	40
4.6.1 Site .....	40
4.6.2 Servicing.....	40
4.6.3 Flexibility .....	41
4.6.4 Planning .....	41
4.6.5 Physical environments requirements.....	41
4.6.6 Environmental impact .....	41

---

---

4.6.7 Facilitation of human processes .....	42
4.6.8 Imagery .....	42
4.6.9 Concluding remarks .....	42
<b>Chapter 5 - Case studies .....</b>	<b>43</b>
5.1 Introduction and selection rationale .....	43
5.2 Doris Duke Medical Research Institute .....	44
5.2.1 Background .....	45
5.2.2 Site and general planning .....	46
5.2.3 Circulation .....	48
5.2.4 Structural system .....	49
5.2.5 Servicing .....	49
5.2.6 Environmental impact reduction .....	50
5.2.7 Finishes .....	51
5.2.8 Other noteworthy aspects .....	51
5.2.9 Conclusions .....	52
5.3 Council for Scientific and Industrial Research, Durban Campus .....	53
5.3.1 Background .....	53
5.3.2 Research process and general planning .....	54
5.3.3 Laboratory requirements .....	55
5.3.4 Storage .....	55
5.3.5 Ownership of space .....	56
5.3.6 General aspects .....	57
5.3.7 Conclusions .....	58
5.4 Block H Physics and Chemistry Laboratories .....	59
5.4.1 Background .....	59
5.4.2 General planning .....	60
5.4.3 Laboratory module .....	60
5.4.4 Servicing .....	61
5.4.5 Work surfaces .....	62
5.4.6 Conclusions .....	63
5.5 Overall conclusions drawn from case studies .....	64
5.5.1 General remarks .....	64
5.5.2 Site .....	64
5.5.3 Servicing .....	64
5.5.4 Flexibility .....	64
5.5.5 Planning .....	65
5.5.6 Physical environmental requirements .....	65
5.5.7 Environmental impact .....	66
5.5.8 Social component .....	66

---

---

5.5.9 Imagery .....	66
<b>Chapter 6 – Formulation of the design brief .....</b>	<b>67</b>
6.1 Introduction.....	67
6.2 Brief derivation.....	67
6.2.1 Client.....	67
6.2.2 Client's objectives .....	68
6.2.3 Funding.....	68
6.2.4 Function and users .....	68
6.2.5 Environmental requirements .....	69
6.2.6 Construction systems and materials .....	69
6.2.7 Site requirements.....	69
6.2.8 Architectural form and massing.....	70
6.2.9 Design objectives .....	70
6.3 The Brief.....	70
6.3.1 Building functions .....	70
6.3.2 Accommodation schedule formulation.....	72
<b>Chapter 7 – Technical and Environmental Criteria.....</b>	<b>73</b>
7.1 Introduction.....	73
7.2 Social facilitation.....	73
7.3 General planning.....	74
7.3.1 Environment sympathetic to human habitation.....	74
7.3.2 Massing.....	74
7.3.3 Work spaces .....	75
7.3.4 Types of laboratories.....	75
7.4 Environmental impact reduction.....	76
7.4.1 General .....	76
7.4.2 Particular strategies .....	78
7.5 Servicing .....	79
7.5.1 General .....	79
7.5.2 Typical distribution.....	80
7.5.3 Gas supply .....	82
7.5.4 Water supply .....	82
7.5.5 Fume extraction .....	84
7.5.6 Laboratory waste .....	84
7.5.6 Workbenches .....	86
7.5.7 Ventilation.....	87
7.5.8 Electrical supply.....	87
7.5.9 Hazardous materials .....	88
7.5.10 Fire systems .....	88
7.6 Safety .....	89

---

---

7.6.1 General .....	89
7.6.2 Safety equipment .....	89
7.6.3 Planning .....	89
7.7 Structure .....	89
7.8 Illumination .....	90
7.8.1 Requirements .....	90
7.8.2 Natural day-lighting .....	91
7.8.3 Colour considerations .....	91
7.9 Finishes.....	91
7.10 Storage .....	92
7.11 General aspects .....	93
7.12 Conclusions .....	93
7.12.1 Efficient planning .....	93
7.12.2 Flexibility .....	94
7.12.3 Human comfort .....	94
7.12.4 Environmental impact reduction.....	94
7.12.5 Specific requirements.....	94
<b>Chapter 8 – Conclusions and Recommendations .....</b>	<b>96</b>
8.1 Introduction.....	96
8.2 The research environment .....	96
8.3 The servicing strategy.....	97
8.4 Flexibility .....	97
8.5 Practical requirements.....	98
8.6 Environmental impact reduction.....	98
8.7 Concluding remarks .....	99
<b>Chapter 9 - Bibliography.....</b>	<b>100</b>
8.1 Books and journals.....	100
8.2 World Wide Web Pages.....	104
8.3 Interviews by Author .....	106
<b>Appendix A – Schedule of accommodation .....</b>	<b>107</b>
<b>Appendix B – Area Analysis .....</b>	<b>108</b>
<b>Appendix C – Structured Interviews outline .....</b>	<b>109</b>
<b>Appendix D – Photographs of physical model .....</b>	<b>110</b>
<b>Appendix E – Design Report and Design Drawings .....</b>	<b>112</b>

---



---

## **Acknowledgements**

Firstly, my thanks to Christ Jesus, through whose undeserved grace I have been able to reach this point.

I wish to thank my family. Mom and Dad, your continuous sacrifices and support are valued beyond measure. Eugene and Jeannette, your support has always been encouraging.

I wish to thank the all of the staff of the school of architecture, housing and planning and the Architectural library staff. Particular thanks need to be conveyed to my document supervisor, Professor Walter Peters, course co-ordinator Alethea Duncan-Brown, past lecturers Professor Derek Wang and Tony Wilson and Tim, Michelle, Janine and Mukesh in the library.

Special thanks needs to be conveyed to my classmates. Our joint struggles and strife have only been bearable because we did it together. To 'The Office' – the last few years would be unimaginable without you guys! Thanks for being the great friends that you are. Thanks also to Catherine Kirk for her support and encouragement in this challenging process.

Particular mention needs to be made of individuals that assisted directly in the research of this document, namely:

- Dave Barrow – project architect for DDMRI
- Adelane Cahu – project technician for DDMRI
- Helen Kisbey-Green – Operations and Administration Manager, CAPRISA
- Gary Parsons – laboratory manager at CSIR
- Gerald Seitter – project architect for Block H Laboratories, UKZN Westville campus renovations
- Dr. Waldemar Szpak – specialist oncologist
- Derek van Heerden – project architect for DDMRI
- Steven Weerts – project leader for CSIR

I will undoubtedly leave out many people worthy of a mention in this document; know that I am well aware that so many more than those listed beneath have contributed to my architectural education.

---

---

## **Abstract**

Medical research is not only a necessary part in the quest to improve the quality of life for people by finding new diagnostic procedures and treatment; it is also a multi billion rand endeavour. Africa itself poses a huge challenge in providing facilities to respond to the global network engaged in medical research. South Africa has responded in part to this need, and is a pioneer in medical research for the continent. In essence, the continent not only provides great challenges, but also great opportunities for research. Many of its facilities engage in collaborative research with global institutions, but these established ties do not adequately fulfil the capacity required.

In addition to this, the research environment is constantly evolving. Not only is the process constantly changing, but also the environments in which the research is conducted and the attitude as to how research should be conducted. To stay as current in the field of medical research, new institutions need to respond to the technical, practical and philosophical changes in the field.

The National Health Laboratory Services, a South African chapter 21 institution involved in research and diagnosis, is the proposed client for the cancer research institute to be designed. It has established research credentials in cancer; pioneering the national cancer register; and has established links to other national organisations, such as the Medical Research Council of South Africa.

---

## **Introduction**

Cancer is not a new phenomenon; there have been recorded incidences of it as far back as 3000 BC in Egypt. Only within the last 150 years has the medical fraternity practically engaged in the problem of cancer. Cancer research at the moment takes on many forms, but the research conducted in the proposed facility is to understand the basic mechanics of the cancer cell and use the knowledge gained to develop new or improved treatments and diagnosis. This research is critical in the fight against cancer, as it currently affects one in five males and one in six females in South Africa.

The facility seeks to provide a suitable environment in which to conduct research by providing for the practical needs and to facilitate the research process through the overall environment created. In this dissertation research, precedent and case studies have been conducted to critically evaluate positive and negative aspects of existing environments and to identify trends that need to be taken cognisance of in the design of new research facilities. Specifications for the building and individual environments will also be presented, which includes strategies to reduce the environmental impact that the building has, which is historically sizeable. These will culminate in recommendations to be implemented in the design of a new cancer research institute for Durban.

## Chapter 1 – Research Background

### 1.1 Background to laboratory design

The phenomenon of the laboratory as a built environment can be traced back to the alchemists cell, a 'mysterious' environment where quasi-science was conducted. (ill 1.1) As the science of chemistry evolved and became more formalised in the early 18<sup>th</sup> century, so too did the environment in which it was conducted to accommodate the increasingly complex apparatus. (ill 1.2) With the introduction of coal gas in the 1850s as a local heat source, piped services to the laboratory bench appeared, followed soon after by water and drainage. As time passed, more elaborate services were included. By the mid 20<sup>th</sup> century, service manifolds supplied a multitude of elaborate services. (Weeks: 1986, 2) The major development in laboratory buildings over the last 50 years or so is the method of servicing, the general planning principles of the laboratory space has remained much the same since the early 18<sup>th</sup> century. (Weeks: 1986, 2) For example, the Salk Institute for Biological Sciences designed by Louis Kahn, commissioned in 1959, is one of the iconic buildings of laboratory design in the 20<sup>th</sup> century. (ill 1.3) It utilised a radical shift in servicing methods and has inspired a generation of laboratory designers. It features as one of the precedent studies in Chapter 4.

### 1.2 Background to cancer research

Research can be classified as a process that involves collecting and examining information to improve knowledge and understanding. Cancer research involved collecting and analysing information about every aspect of the disease, from its basic biology to the effects of treatment. (Cancer Research UK: 2004)

The occurrence of cancer is not a new phenomenon. The oldest recorded instances can be dated back to 3000 – 1500 BC in ancient Egypt, while Hippocrates is credited with being the first to recognise the difference between benign and malignant tumours. By unravelling the structure of DNA in 1953,



Illustration 1.1: The Painting "The Alchemist in Search of the Philosopher's Stone", by Joseph Wright, 1771. This illustrates the dark and mysterious environment from which modern day laboratories are descendent.

Source: (McLean: n.d.)

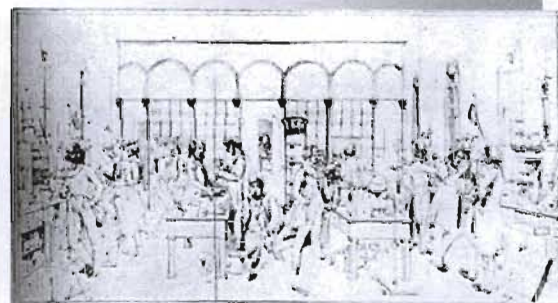


Illustration 1.2: A sketch depicting Liebig's laboratory at Giessen circa 1842. The environment has become more formalised and caters for more elaborate equipment.

Source: (Weeks: 1986, 3)



Illustration 1.3: A view from the lower terrace of the Salk Institute, an Icon of laboratory design in the 20<sup>th</sup> century.

Source: (Nakano: 2006, n.p.)

Francis Crick's and James Watson's monumental breakthrough enabled researchers to study and understand cancer cells at the molecular level and thereby develop new treatments and diagnosis. (Cancer research: 2004)

According to Cancer Research UK (2004), cancer research can be broken up into the following five main areas:

- Basic research – This is the study of how cells work in order to understand what makes cancer cells different. This research does not focus on finding a new treatment.
- Translational research – Findings from basic research are applied to create potential new treatments or diagnostic tests.
- Clinical research – This involves clinical trials that can be broken into 4 phases and are carried out in hospitals and usually involves cancer patients.
- Behavioural and population research – This aims to identify things that influence the risk of an individual developing cancer, thereby trying to find ways to reduce the risk and prevent cancer from occurring.
- Psycho-social research – This research looks at the emotional and social impact of cancer on individuals with the goal to improve their quality of life.

According to the South African National Cancer Registry, the incidence of cancer in 1999 affecting the population was one in five males and one in six females (Mqoqi et al.: 2004, 18) This indicates that cancer has a great impact on society. Research aims to reduce this impact by understanding how cancer develops in order to prevent it and to develop better treatments and diagnoses. By providing more research opportunities, such as that which will be provided by the construction of this Cancer Research Institute and Laboratories for Durban, a meaningful contribution could be made to the fight against cancer.

### **1.3 Background to facility**

This Institute will consist of research facilities such as laboratories and their support functions, researcher's and administration



Illustration 1.4 and 1.5: Scientists engaged in cancer research.

Source: (Cancer Research UK: 2004, n.p.)

staff offices, a library, and seminar rooms. The facility will be involved in basic research. There is no clinical component to the research being conducted, therefore the users will be staff, visiting professionals collaborating with staff, or attending the occasional seminar and limited personal visitors of the staff. The facility is not open to the general public.

#### **1.4 Research problem**

A research facility is a highly complex environment. In addition to the standard accommodation and support spaces one expects in any institutional building, the additional laboratory component requires particular servicing, and special environmental requirements. The architect is called upon to meet these stringent practical requirements and to create an environment conducive to research. The broad research question for this document therefore is: What is an appropriate design response for a medical research institute for Durban?

##### 1.4.1 Design response

The designer is faced with the challenge of a brief that is dominated by functional requirements. The laboratory component seems to dominate the process due to their very specific nature. The challenge, therefore, is how to balance the functional requirements with the fact that the institute is still an environment in which people work and interact. A design needs to facilitate the entire research process, from conceptualisation of a research idea through to publication of results at the conclusion of a research program. This needs to take cognisance of the fact that the laboratory is merely the place in which ideas are tested. Ideas are conceived when both formal and informal inter- and multi-disciplinary interaction takes place. (ill 1.6) (Seitter: 2007)

##### 1.4.2 Building brief paradox

The nature of researchers is to be focused on their individual research project. They understand their needs implicitly, and will urge for a specific design response to their immediate needs when consulted (van Heerden: 2007). The temptation is to then design an environment suitable for the needs of the initial users (Weeks: 1986, 4). Changing technology and



*Illustration 1.6: Staff at the CSIR Durban campus interacting informally during their lunch break at the cafeteria. Though assigned to different research programs, the interaction allows for ideas to be shared and conceived.*

research programmes have a fundamental impact on the building throughout its lifecycle. (Griffin: 2000, 85) The paradox exists in that current needs have to be catered for in addition to future needs, which are virtually impossible to predict. (Griffin: 2000, 3) "The major area for design decisions is in the services and the means whereby these can be made available flexibly, usefully, and with the minimum of obstruction to the free use of the whole floor space available." (Weeks: 1986, 3) The problem for the designer is therefore to determine the most appropriate service and program strategy.

### 1.5 Key questions

- How can the quality and quantity of research be improved by the built environment?
- What particular design strategies can be implemented to facilitate inter- and multi-disciplinary interaction?
- What is the most appropriate design approach to deal with immediate and future requirements of the facility and its services?
- What are the practical requirements of the laboratory and their support spaces?
- What particular environmental sustainable design principles are feasible for the design and how can they be implemented?
- How should the facility relate to its macro and localised context?

### 1.6 Working hypothesis

The working hypothesis informing this research document is two-fold. Firstly, a pleasant environment that facilitates social interaction leads to a more productive workplace. Secondly, the appropriate servicing and flexibility of the facility is key to its immediate and long term success.

### 1.7 Aims and objectives of the study

- The standard design response implemented with many laboratory buildings is overwhelmingly functional with either the laboratories themselves or the researcher's offices tending to be internalised spaces. (ill 1.7 and

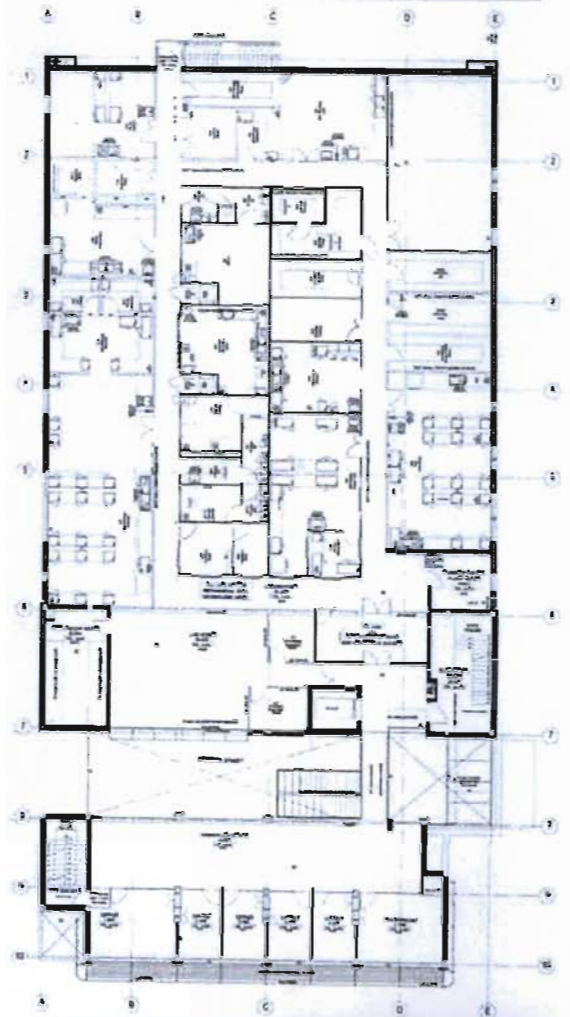


Illustration 1.7: Upper floor plan of the BIOVAC Vaccine Laboratory, Ndabeni, designed by StudioMAS Architects recently featured in *Architecture South Africa*.  
Source: (Coetzer: 2007, 88)



Illustration 1.8: An exterior shot of the BIOVAC building with the prominently screened administration offices in the foreground. During the keynote address at the KwaZulu-Natal Institute of Architects 2007 Awards for Architecture, the Cape Town based architect and winner of a 2007 DaimlerChrysler arts Award, Heinrich Wolff, described it as a building made for the journal photo.  
Source: (Coetzer: 2007, 89)

1.8) The study aims to find appropriate contrasts to this standard design practice.

- The institute has a large impact on the environment due to the research process being an intensive user of resources. An appropriate response to minimise this impact will be investigated.
- There is a great contrast in requirements between the laboratory and ancillary spaces. Usually these are treated in the same manner. The document will seek to determine an appropriate balance between these spaces in order to create an environment that responds not only to the needs of the institution, but also to the individual.
- The study also aims to determine the basic design requirements, such as siting, planning, structure, materials and the like, and strategies to fulfil these requirements.

### **1.8 Conclusion**

Though cancer is not a new phenomenon to the human race, it still impacts society greatly. The more we know about it, the greater the chance there is of developing new and better treatments and diagnoses in order to reduce the impact on society as a whole.

Over the centuries, research and the environments in which it is conducted have evolved and continue to do so. Currently, research encompasses an inter- and multi disciplinary focus. This coupled with research programs having limited life spans, laboratory design needs to respond to current and future requirements and create an environment to influence the quality and quantity of research being conducted. The standard design response, though practical, leaves much to be desired in terms of place-making and minimising environmental impact. Better solutions to the design need to be sought by critically analysing the requirements and then responding creatively, this type of building need not be banal.



---

## **Chapter 2 – Research Methodology**

### **2.1 Introduction**

In this chapter, the method of data collection will be defined and explained. The area set for the study is Durban, the largest metropolitan area of KwaZulu-Natal, South Africa. The data gathered here is used as a sample, representative of both national and international trends in the field. The study area also allows for the examination of conditions and aspects specific to the region in question in relation to the application of findings. The collection and synthesis of this data is to answer key questions in relation to the development of a design brief for a new Cancer Research Institute for Durban.

### **2.2 Research plan**

The research consists of both primary and secondary collection methods. The rationale for this is as follows:

- 1) The use of secondary research methods allows for the establishment of a general consensus pertaining to the key research questions. It allows for a global perspective to be applied to the areas of investigation, which will then be evaluated in terms of application and relevance for the study area. The research will then focus in on the study area.
- 2) The use of primary data collection allows for the testing of the working hypothesis and allows for the comparative evaluation of secondary data collected. It also allows for the author to gain firsthand experience of the environment in which the research is being conducted.

The focus of the research is qualitative rather than quantitative. The research does not primarily set out to give absolute answers to key questions by means of statistical data to substantiate the answers. The research does set out to identify trends in general and to contextualise findings to the study area to lead to an informed understanding of the issues.

### **2.3 Secondary data**

A literature review has been conducted and consists of research institutes in general as well as medical research institutes specifically. The rationale for including general research institutes is that many of the aspects apply across the board and are the same in a cancer research institute as in any other research facility.

Actual and published architectural projects are scrutinised in addition to information of the nature and process of research with the aim to give architectural form to facilitate the phenomenon. This is restricted to a brief examination thereof, and focuses primarily on the architectural implications of the findings.

Other architectural aspects not specifically linked with research institutes, but identified as avenues of investigation by the theoretical framework are also included. These aspects can be implemented in a variety of built environments and are positive and relevant are intended to be implemented in the design.

Sources of this secondary data include published materials, such as books, journal articles and internet pages. Non-published materials such as design and construction drawings are also consulted.

A critical analysis of precedents has been conducted, and the criteria for the selection of appropriate projects are to enable the investigation of the following aspects:

- The appropriate design approach.
- Appropriate and favourable location of an Institution.
- Integrated servicing.
- Need for flexibility and the strategies to implement.
- Overall functional arrangements.
- Functional requirements of different environments.
- Minimisation of environmental impact.
- Human functioning within the specific environment.

In light of the criteria set out, the following comparative research laboratories were selected as precedent studies:

- Schlumberger Cambridge Research Limited, Cambridge, United Kingdom, completed in 1985.
- The Salk Biological Research Institute, La Jolla, California, USA, commissioned in 1959.
- The Salk Biological Research Institute Additions, La Jolla, California, USA, completed in 1996.
- The Neurosciences Institute, La Jolla, California, USA, completed in 1995.

#### **2.4 Primary data**

The Primary data consists of interviews with key informants. Though areas of investigation were set, the interviews were structured in an informal manner to allow for the individuals being interviewed to add pertinent information not initially included in the fields of investigation, as they saw fit. These key informants include medical researchers, laboratory staff and architects.

The structured interviews questions for designers focussed on the areas of the design program, servicing, and the physical components. The designers interviewed include Dave Barrows, Adelein Cahi and Derek van Heerden, who were involved with the Doris Duke Medical Research Institute (DDMRI), and Gerald Seitter who was involved with the Block H physics laboratory.

The structured interviews questions for researchers focussed on the areas of medical research in overview, the work environment, servicing, and physical planning. The researchers interviewed include Helen Kisbey-Green, the operations and administration manager of CAPRISA, based at DDMRI, Gary Parsons, the laboratory manager and Steven Weerts, project manager, based at the Coastal and Marine Pollution division of the Natural Resources and the Environment – CSIR Durban, and Dr. Waldemar Szpak, an Oncology Radiotherapy Specialist, previously based at Inkosi Albert Luthuli Central Hospital.

A list of topics and questions used as a guideline for the interviews is attached (Appendix C – found on page 109). It also consists of case studies of research environments based in the Durban areas.

The criteria used in the selection of case studies included:

- Proximity to study area;
- Ability to investigate aspects identified in the precedent studies; and
- Ability to compare and identify trends in design.

Therefore the following case studies were selected:

- Doris Duke Medical Research Institute (DDMRI), Nelson R. Mandela School of Medicine, University of KwaZulu-Natal (UKZN), completed in 2003.
- Council For Scientific and Industrial Research (CSIR), Durban Campus, completed in 1959.
- Block H Physics and Chemistry Laboratories, Westville Campus, UKZN, renovation underway in 2007.

The primary data enables for:

- Conclusions to be drawn on the appropriateness of design aspects and implementation;
- Identification of current trends in research environments; and
- An understanding of the individual users' perspectives.

## **2.5 Data synthesis**

Findings and observations from the primary and secondary data were then synthesized to inform the design process and to develop a brief and propose design recommendations for a new Cancer Research Institute for Durban.

## **2.6 Conclusions**

The informal discussions with individuals being interviewed allowed for the introduction and discussions of areas of importance not considered by the author prior to the meetings. The case studies also demonstrated the practical applications of some recommendations made in the conclusions drawn from the precedent studies and enabled

---

the level of their success to be established. The case studies also allowed for a first-hand evaluation of the entire research environment, and presented the opportunity to react as any normal visitor to the building would, thus giving insight into a visitors' perspective.

---

## **Chapter 3 – Literature Review and Theoretical Framework**

### **3.1 Introduction**

This particular chapter will deal briefly with a review of literature concerning research facilities and an examination the theoretical framework that will inform the design of the New Cancer Research Institute and Laboratories for Durban. The literature review examines the predominant focus of the design process and the translation thereof in the built form in past research institutes and the evolution of the building type. The theoretical framework examines the relationship between knowledge and power, the management system and the intended goals of the Institute. Particular design strategies are recommended to respond to the management system and intended goals.

### **3.2 Literature review**

#### **3.2.1 Evolution and current issues of the laboratory environment**

The laboratory environment has changed in many ways since its origin in the alchemists' cell. The more formalised environment can be seen as far back as the 1850s, when a localised heat source was introduced with coal gas being piped to the workbench. The evolution of the layout of the laboratory has not altered much in over a century; there is an isle of fairly uniform width with a workbench on either side. (Weeks: 1986, 2) It is the servicing of the laboratory and the institutional operation where significant changes have occurred.

For the most part of the last century, laboratories have been in the domain of educational institutions and have been purposely constructed to suit a specific research objective. More recently, though, funding at these institutions for research has diminished. This has resulted in the trend of institutions attracting funding through public and private sponsorship for applied research. This, in turn, has resulted in formerly dispersed programs being rationalised and unified into individual institutions with a mix of research programs. These research

programs have become more susceptible to the available funding and research priorities of business and government, and this has a direct impact on the mix and duration of research programs. The research environment has therefore needed to respond to the tendency for more frequent change by the built environment being characterised by flexibility. (Kroloff: 1996, 95)

Though still remarkably similar, the laboratory layout has responded to the need for flexibility by regularising the planning module (1500mm x 1500mm) and has tended towards adaptable and removable workbenches replacing fixed benches and having mobile casework where practical. This allows for ease of modification when needed. (Griffin: 2000, 21, Watch:2002, n.p.) The planning of the environment has also become more concerned with occupational health and safety as time has progressed. The inclusion of more safety equipment, greater visibility between laboratories and greater wheelchair user friendly environments has impacted the laboratory environment. (Griffin: 2000, Seitter: 2007)

Servicing has demonstrated the greatest evolution in the laboratory environment. From the early days of formalised laboratory environments, the amount of services supplied to the workbench has steadily increased to now include a whole host of electrical and mechanical supply and exhaust. (Weeks: 1986, 2) The servicing approach has been refined over the years. A balance between servicing requirements, funding and, as of late, environmental impact all factor in to the design. This evolution can be seen in different projects which are analysed later in the document. Kahn's Salk Institute (a Chapter 4 case study) sought to satisfy the immense servicing requirement and need for flexibility with a vast interstitial floor for each laboratory floor. This has resulted in exceptional serviceability of the laboratories, but at a great initial cost. (Loring: 1986, 9, 69)

With more recent financial constraints, spaces for servicing have been curtailed. Demonstrations of this can be found in the additions to the Salk Institute (another Chapter 4 case

---

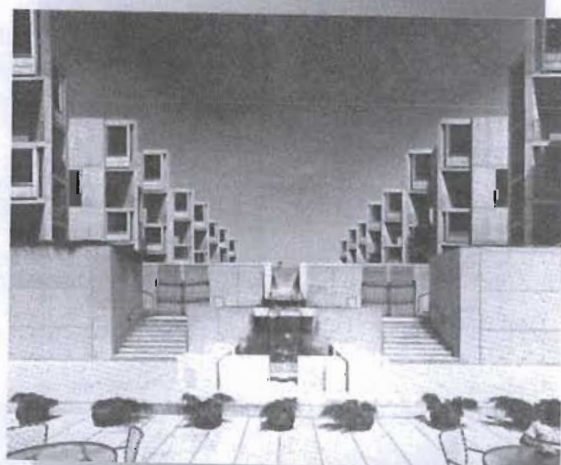
study) and the Doris Duke Medical Research Institute (a Chapter 5 precedent study. Due to the laboratory being a resource hungry environment, recent developments in systems and technology, and a greater focus on passive design have gained prominence. This has been touted as an attempt to be more environmentally conscious in design, but also directly relates to reducing running costs and in response to stricter governmental regulation globally. Particular strategies are discussed in Chapter 7, and a building worth noting in this regard is Schlumberger Cambridge Research Ltd, a Chapter 4 case study.

### 3.2.2 The need for prioritising the human process

Aldo van Eyck identifies that the tendency for institutional buildings is to translate to 'a well-oiled service machinery' in which the inhabitants are to fit around the machinery. (Van Eyck: 1999, 88) This seems particularly acute in laboratory and research buildings. The process of research and servicing dominates the literature, and authors, such as Braybrooke (1986) Diberardinis et al. (1993) Griffin (2000) Harrell (1974) etc., stress that designers have a clear understanding of the mechanical process and pattern involved in research.

This is indeed correct, as the facility needs to be well conducive to the purpose for which it was constructed. (The particular and necessary functional aspects are dealt with in Chapter 7 of this document.) The missing component, however, in most of the literature published is the fact that these facilities are staffed by humans. The human element seems vastly less significant than getting the mechanics of the process right. Some authors, such as Griffin (2000), make reference to ways in which the facility can become more accommodating of the staff, but it seems to constitute the addition of social spaces (ill 3.1) to the design rather than the acknowledgement of human nature as a basis for design.

An example of a design dominated by a research driven process is the PA Technology Facility in Hightstown, New Jersey, U.S.A, designed by Richard Rogers Partnership. (ill 3.2) The building translated into a "well-serviced shed" suited to mechanical and spatial requirements (Boles: 1985, 70) The



*Illustration 3.1: The lower terrace at the Salk Institute acts as the central social space for the staff of the facility. Sadly, in many designs, social spaces like these are given little thought other than that they need to be included.*  
Source: [Weeks: 1986, 5]



services are its "central authoritative act, its moral" (Sorkin: 1985, 38). The commentary on the building seems to infer that the design infers lip-service to the social aspect, and is un-conducive to facilitating social interaction. (Sorkin: 1985:41).

### 3.2.3 The architectural expression of research environments: sculpture versus services

John Weeks identifies two results of the highly serviced requirements in a laboratory building, namely that laboratory designs do not generally attract 'star' architects or when they are commissioned, they usually articulate functions into separate zones. The result is that laboratory buildings tend to be 'exceedingly useful' but bland in the former instance or an architectural 'masterpiece' that has functionality and flexibility concerns in the latter instance. (Weeks: 1986, 4)

Increasingly, designers try to address the utilitarian nature of the building by designing existing aspects as elements of accent, such as the 'significant insignificants' (Cahi: 2007) featuring in the Chapter 5 Case study of the Doris Duke Medical Research Institute. Lobbies, staircases, social spaces and facades are enlivened, but the building remains utilitarian in its overall design. This is in itself not undesirable, but an opportunity is lost to create a space that is more than just a research machine with some soft touches for the people that inhabit it.

'Masterpiece' laboratories and institutes are well known and are generally more famous for their artistic qualities. Two of the most renowned laboratories are Louis Kahn's Richard's Medical Research Building (ill 3.3 & 3.4) and The Salk Institute for Biological Sciences. The latter features as a Precedent study in Chapter 4. The Richard's building heralded in a new era in services design, with its prominent vertical brick service shafts, and received thousands of admiring visitors a year. This aside, the building does however raise serious concerns over usability and flexibility. (Weeks: 1986, 4) The lack of praise by the users of the Richard's building is also highlighted in the 2003 documentary, *My Architect*, by Kahn's son, Nathaniel.

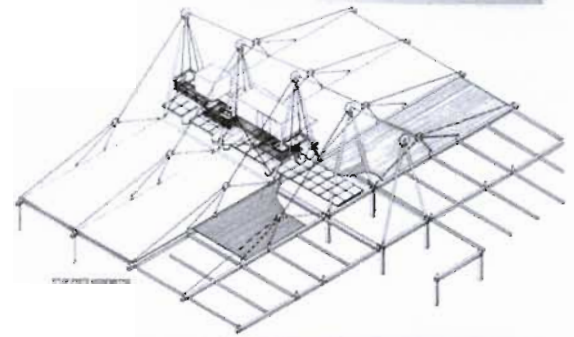


Illustration 3.2: An Axonometric drawing of the PA Technology Facility by Richard Rogers Partnership. The building is exceedingly well resolved structurally, but the approach of making it a "well-served shed" diminish the importance of the staff that work in the building within the design process.

Source: (Boles: 1985, 72)



Illustration 3.3: An exterior view of the Richard's Medical Building at the University of Pennsylvania. The prominent vertical brick service shafts are clearly evident.

Source: (Weeks: 1986, 4)

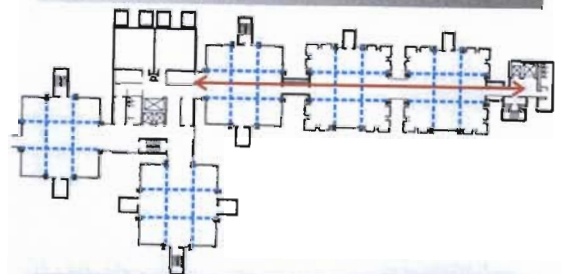


Illustration 3.4: A typical floor plan of the Richard's building. Kahn's preoccupation with the square form resulted in each major space comprising nine smaller squares. Criticisms include an incorrect module size and poor circulation, with occupants having to move through the centre of one space to get to another.

Source: (Righini: 2000, 123)

The Salk Institute, with its interstitial service space, became the pinnacle of flexible servicing to laboratories. The dominant feature of the plaza with a view to the Pacific Ocean (ill 3.5) is certainly breathtaking, but the treatment thereof results in it being an uncomfortable outdoor space that is the least used of all outdoor spaces by the staff. (Treib: 2006, 414) It also drastically divides the Institute into two distinctive halves, which is not conducive to multi-disciplinary interaction and "tends to freeze the institution into patterns of organization of work which may not endure". (Weeks: 1986, 5)

### **3.3 Theoretical framework**

#### **3.3.1 Research as a social phenomenon**

In the world of medical research, the adage 'time is money' has relevance on multiple levels. Funding is allocated for projects and is not open ended. In commercial laboratories, scientists are always trying to stay one step ahead of the competition. In addition to this, the research undertaken can have significant positive benefits for vast amounts of individuals that may not have the luxury of time. A positive research output in the shortest time is the goal. Inter- and multi-disciplinary interaction has a positive impact on individual research projects, and results in advances. (Kisbey-Green: 2007, Watch: 2007, n.p.) This goal is achieved when science is seen and facilitated as a social activity.

*"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.)



Illustration 3.5: A view of the main plaza at the Salk Institute with the Pacific Ocean in the distance. The plaza divides the facility into two distinctive parts, and the treatment thereof does not facilitate the interaction of staff between the two parts.

Source: (Yusheng: 2006, n.p.)

It holds then that a successful and productive Institute is one where social interactions, both formal and informal, are facilitated and encouraged by both management and the built environment.

### 3.3.2 The impact that management structures have on research environments

In a management system that is hierarchical in nature, people tend to become relatively confined to their own area of specialization. (Allen: 1998, n.p.) This is contrary to the inter- and multi- disciplinary interaction sought in modern science. Secondly, Brokaw (1993, n.p.) holds that a flat management structure assists in creativity, while a hierarchical system may frustrate creativity. Creativity is an important element in scientific research, as the laboratory is only the place where a creative idea gets tested. (Seitter: 2007) Further to this, Harrison-Broninski implies the need for interaction between individuals involved in a project even though they may be operating in isolation. (2005, 3) The individuals involved in a task require support, and part of this support is allowing 'information resources' to be passed via interactions. (Harrison-Broninski: 2005, 2) Though the 'information resources' and interactions are unspecified by Harrison-Broninski, it is quite reasonable to conclude that this can be achieved by formal and informal interaction.

### 3.3.3 The impact of Power-Knowledge on the design of research environments

The French philosopher, Michel Foucault, identified the notion of power-knowledge. This refers to the principle that gathering and possession of knowledge inherently gives the individual or institution with the knowledge power over those who do not possess that knowledge. This particular notion has led to the identification of the 'institutionalization of science' – being that the domain of science and the scholarship thereof has been taken from a general realm and being vested in particular institutions and individuals, such as a medical research facility and the researchers that work there. (Horrocks et al.: 2004, Mason: 2008)

By obtaining and retaining this knowledge, the institution and individuals exercise differing levels of power over those who do not possess the knowledge. This 'domination' of knowledge, and therefore the inherent unbalanced power that is gained thereby is legitimised by the traditional 'top' down approach in

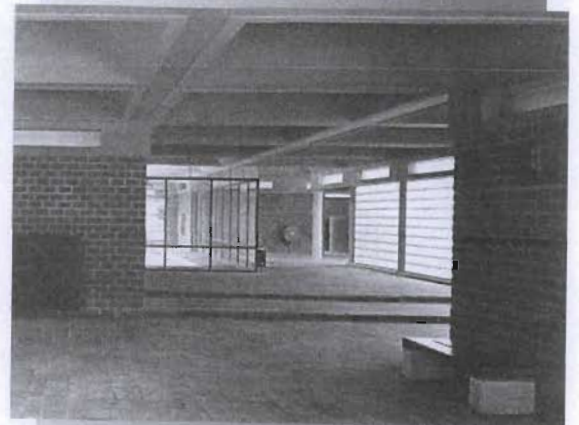
the staff structure, as individuals are 'fabricated' in the unbalanced power relationship. (Mason: 2008) Not only can this manifest as an unequal scholarly relationship between colleagues at the same institution and an unhelpful and unbeneficial competitive relationship between departments and institutions, but also the mystification of the scientific field from the general population.

This 'disciplinary power' organises thinking about knowledge and controls the process of knowledge creation as a whole. The potential is that the process may come under an oppressive influence. (Mason: 2008) In light of medical research increasingly being recognised as a social and interactive activity in which both formal and informal interactions are seen as important to research output (Kisbey-Green: 2007, Watch: 2007), an environment that encourages the incidental sharing of knowledge should be constructed to alleviate individuals having a 'domination' of knowledge. Particular devices to achieve this through creating a social building are examined next.

### 3.3.4 An environment for social interaction

*"Since man is both the subject and object of architecture, it follows that its primary job is to provide the former for the sake of the latter" (Van Eyck: 1999, 89)*

The quest for a social building implies a public realm that is conducive to interaction. In his Amsterdam Orphanage, Aldo van Eyck conceived the complex to be a 'small self-contained city' and once this association was made, it allowed for the adding of a new dimension to the quality of the communal places. (Hertzberger: 1999, 22) It was deliberate that he anchored spaces to the street (ill 3.6) – the public sphere – so as to save the house from becoming a 'bad house'. (Van Eyck: 1999, 89) This placing of spaces that open onto a larger interior street encourages the children to interact with one another. (ill 3.7) (van Eyck: 1999, 89) It is this encouragement of individuals to interact in a public domain that saves a facility from becoming 'bad' and allows for the building to respond to



*Illustration 3.6: To encourage children from different departments to interact with each other, van Eyck conceived that the Orphanage was a 'small self-contained city' and anchored spaces to the internal street. Source: (Van Eyck: 1999, 93)*

the nature of human interaction and encourages the important inter- and multi-disciplinary interaction.

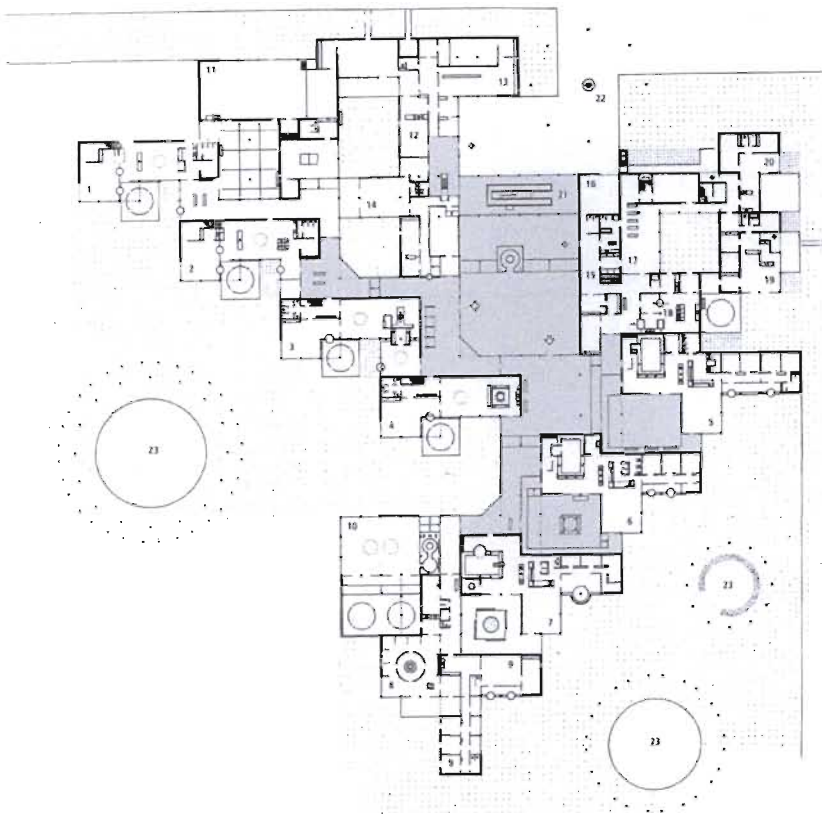


Illustration 3.7: The Ground floor plan of Van Eyck's Amsterdam Orphanage. Different departments open out onto the internal street to encourage interaction between children.  
Source: (Van Eyck: 1999, 94)

In addition, Alexander (1977) supports the notion of a series of smaller elements being located along a route.

*"In short, the more monolithic the building is, the more it prevents people from being personal, and from making human contact with the other people in the building." (Alexander: 1977, 470)*

Walljasper (2006) identifies a "dawning realization" that the creative atmosphere is enhanced by creating better places for interaction. (ill 3.8) Though his discourse is based on campus urban planning, some strategies to a building are still applicable, especially in light of van Eyck's notion that a building parallels an urban landscape. Particular strategies put forward by Walljasper that are applicable to this type of facility are:

- Bringing people and ideas together by creating strong public realms wherein people will naturally 'synergise'.



Illustration 3.8: By creating better places for interaction, the creative atmosphere is improved. This is increasingly acknowledged in campus urban planning, but the principles can still be applied to individual buildings.  
Source: (Walljasper: 2006, n.p.)

- Creating places, not just facilities by clustering activities together to create a busy dynamic place.

### 3.3.5 The 'Internal Street' as a device for a social environment

The prominent organizational device advocated for an institutional building by Alexander (1977), Hertzberger (1999) and van Eyck (1999) for institutional buildings, such as this cancer research institute, is the internal street. Applying Walljasper (2006) campus planning strategies also suggests the use of the internal street as an organizational device.

Alexander suggests that to recreate social intercourse, the route taken between places need to be conceived of as a truly public space. (1977, 490)

*"When a public building complex cannot be completely served by outdoor pedestrian streets, a new form of indoor street, quite different from the conventional corridor, is needed." (Alexander: 1977, 493)*

Elements Alexander (1977, 490 – 498) recommends that can be employed to increase the life on the street include:

- Individual wings having their own entrances that open onto the street.
- Indoor staircases, corridors and lobbies should as far as possible be eliminated.
- Entrances from all upstairs offices should open directly onto the street.
- The street should invite free loitering.
- The street should have a width so that people feel comfortable walking or stopping. The recommended width is 4.5 to 6 meters.
- The ceiling should be at least 4.5 m high.
- If seating is included along the edges, the ceiling height above the seating zone should reduce. Upper storey walkways can be used to form the lower places.
- The street should have a glazed roof if possible.
- The path into the building should be as continuous as possible.

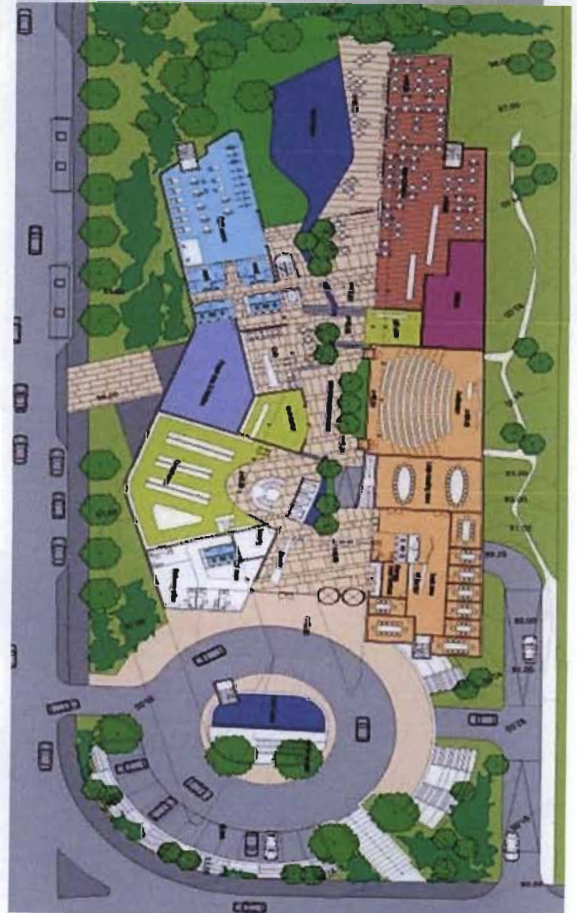


Illustration 3.9: A general plan of the new corporate headquarters for the Royal Jordanian Airlines, Amman.  
Source: (World Architecture News: 2007, n.p.)

- The street should be lined with places to stop, such as bulletin boards, exhibitions and displays.

The internal street has been employed in numerous more recent buildings, mostly corporate offices. Niels Torp Architects have employed the internal street in the British Airways Corporate Headquarters, Harmondsworth, England (ill 3.10 & 3.11) (Davey: 1998, 34 – 47, Duffy: 1990, 26 - 31) and more recently in the new corporate headquarters for Royal Jordanian Airlines, Amman, Jordan. (ill 3.9 on previous page) (World Architecture News: 2007) These buildings have the benefit of accommodating large numbers of users, over 3000 in the case of the British Airways building. On a smaller scale, the RMC International Headquarters building in Thorpe, U.K. by Edward Cullinan Architects (ill 3.12) also uses the internal street as a design device. Social spaces feature prominently along the internal street, with a combination of formal and informal treatment of spaces to suit the function. (Davey: 1990, 59 – 67, Giles: 1991, 41 – 43)

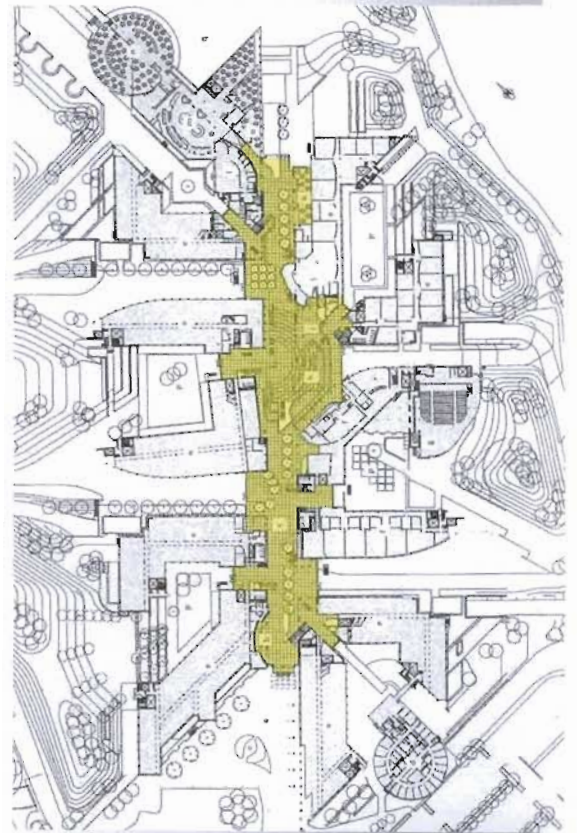


Illustration 3.10: The ground floor plan of the British Airways Headquarters offices in England. Over 3000 employees work in different departments, and interact in the internal street. Source: (Davey: 1998, 37)

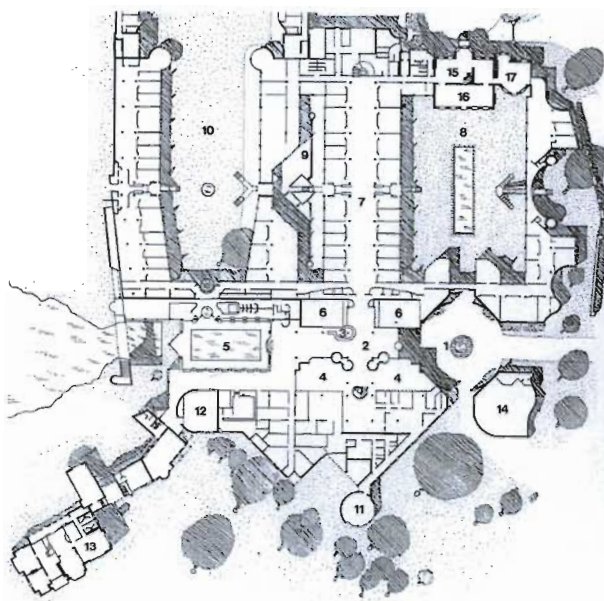


Illustration 3.12: Plan of the RMC International Headquarters featuring an internal street with prominent integration of social spaces along it. Source: (Davey: 1990, 60)



Illustration 3.11: A view of the internal street in the British Airways HQ offices. Cafeteria seating and vertical circulation open onto the street. Source: (Davey: 1998, 40)

### **3.4 Conclusions**

Institutional buildings tend to be a well-oiled service machine with people occupying the space around the machinery. (Van Eyck: 1999, 88) This tendency seems to be that much more acute with laboratory buildings due to their dominating and vast service requirements. The architectural solution to these buildings generally tends to be extremely utilitarian or sculptural, but both schools of thought generally do not engage users on a fundamental design level.

Research itself is a social phenomenon, the most productive and successful scientists are familiar with each other's work. There is the tendency for unequal power relationships between institutions and individuals to develop. The architecture and the management of the institution should facilitate staff interactions to encourage this familiarity and breaking down of unequal power relationships with a building and a flat management structure. What constitutes a social building is one where the public and more private realms are conducive to interaction. By using an internal street as a design device, this interactive environment can be created.



## Chapter 4 – Precedent Studies

### 4.1 Introduction

In the selection of precedents, the focus has mainly been on medical research laboratories, namely: the original building of Salk Institute for Biological sciences, the recent addition to it, and the Neurosciences Institute. A study on the Schlumberger Cambridge Research Limited has also been included. Though it is a facility for researching off shore oil drilling; it is a highly commendable building that has a significant contribution to make in terms of adding insight into research laboratories in general.

The inclusion of a locally based precedent study was desired, but not possible as there are not many South African medical research laboratories published at all. Where information is sufficient, the facilities are generally for socio-medical research or primary community health care and these do not include the laboratory component required for this research. In addition, the existing articles on local medical research laboratories have limited information on the specific building.



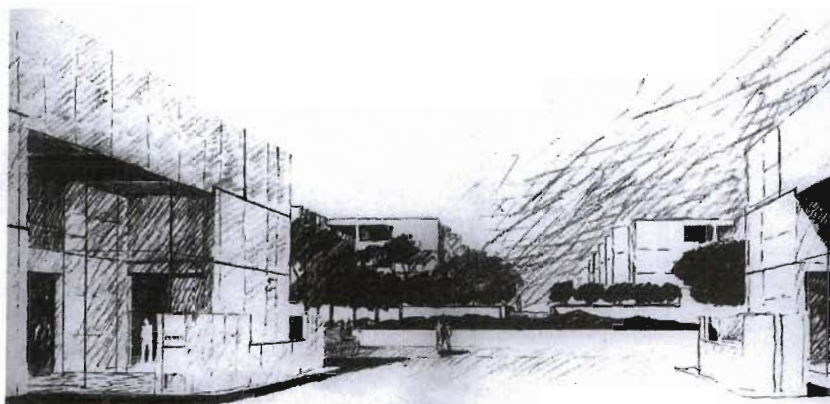
**Precedent Study 1:** Schlumberger Cambridge Research Ltd.

Source: (University of Sherbrooke: 2007, n.p.)



**Precedent Study 2:** The Salk Institute for Biological Sciences

Source: (Jones: 2004, n.p.)



**Precedent Study 4:** Extension to The Salk Institute  
Source: (Crosbie: 1993c, 48)



**Precedent Study 3:** The Neurosciences Institute  
Source: (Dietsch: 1996, 84)

## 4.2 Schlumberger Cambridge Research Ltd.

Architects: Hopkins Architects

Location: Cambridge, United Kingdom

Date: 1982 – 1985

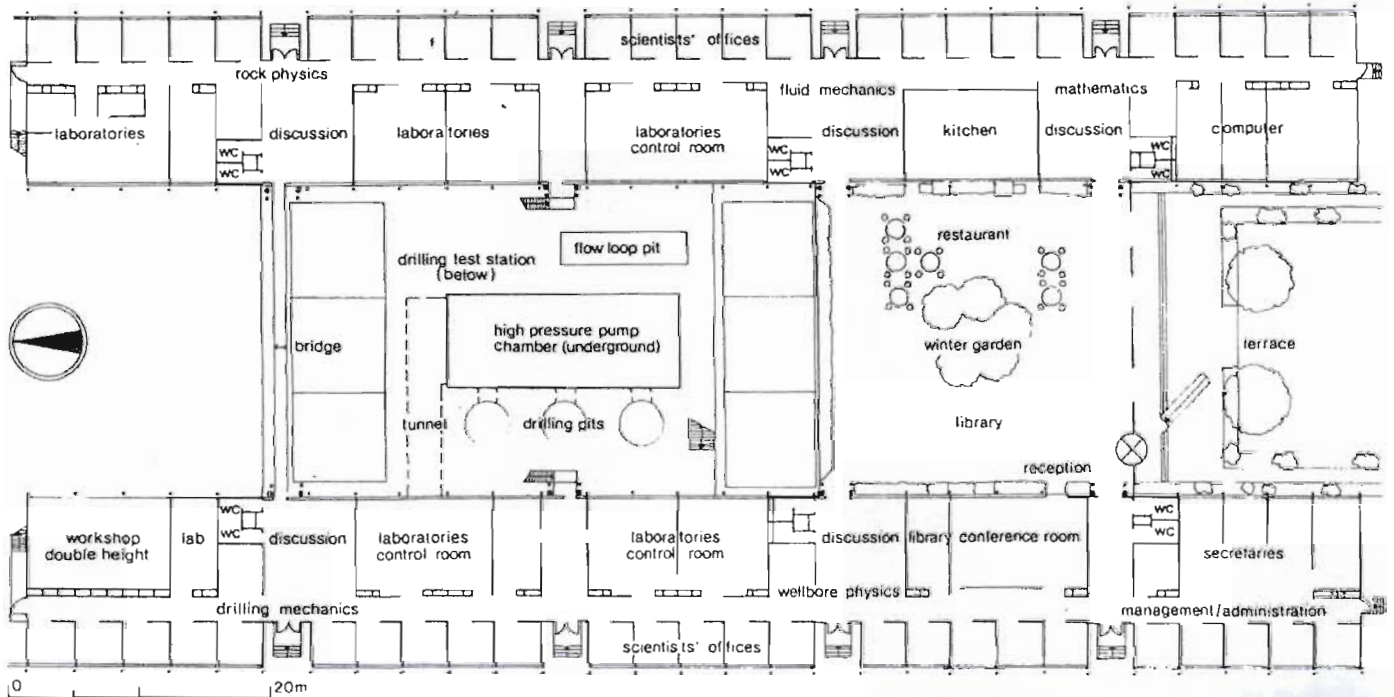


Illustration 4.1: Plans of the first phase of the 5600m<sup>2</sup> Schlumberger Cambridge Research Ltd. The facility comprises a drilling test station, a pump station, laboratories, offices, conference rooms and a restaurant. The testing station, would usually be housed in a separate building, but in this instance is integrated into the overall building.

Source: (Haward: 1984, 45)

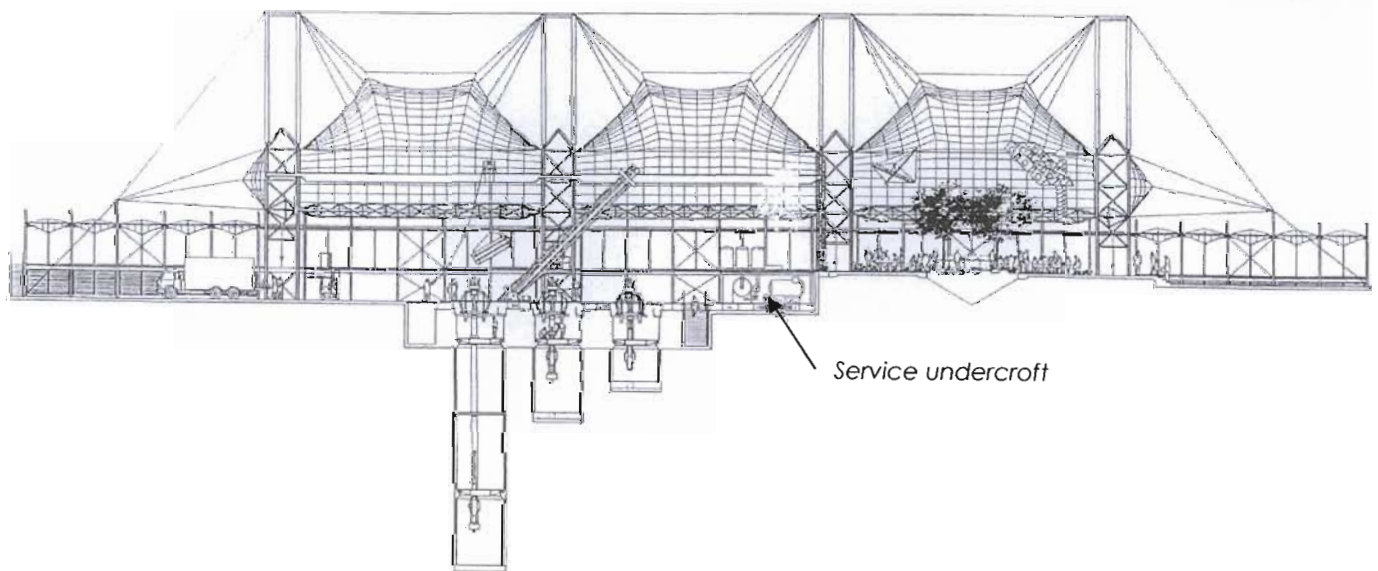


Illustration 4.2: Longitudinal section depicting the different levels of the test station and winter garden. Notice the service undercroft to the right of the sunken test station

Source: (Haward: 1984, 13)

#### 4.2.1 Background

The Schlumberger Company wanted to establish close links with other institutions within an area that had research expertise, as this would allow for the easy interaction of staff from the company with academics and researchers from other institutions; therefore the company decided to locate the facility in Cambridge, UK. The site chosen was on gradually sloping land owned by Cambridge University located to the west of the town centre and in proximity to two other research centres, also built on University owned land. (ill 4.3) All three facilities are private enterprises that lease the land from the university. The site afforded long views to the south and west, and being close to the town centre, a network of cycle and footpaths link it to the town.

#### 4.2.2 Client's brief

The clients were after a facility that was "...creative yet functional, attractive but not flashy. First impressions should not lead to later disappointment; the quiet professionalism of the design should become apparent as one gets to know the building." (Haward: 1984, 43) The client stressed that the design accommodated "...the need for maximum contact between scientists of different departments, and the provision of facilities for visits and meetings with university personnel and staff from other Schlumberger companies." (Haward: 1984, 41) The brief also included special requirements for some of the facility's areas such as lighting levels, noise levels and temperature, and spatial conditions, for example a clear height of 10m within the testing station.

#### 4.2.3 Planning resolution

The building takes the form of two open-ended strips of accommodation separated by three almost square modules, more evident in cross-section than in plan. (ill 4.1 & 4.2) The central and north modules form the enclosure to the test stations; while the south module encloses the winter garden, which houses the restaurant and library. (ill 4.4) The strips are comprised of double loaded corridors with individual offices for scientists located on the outer-facing area; while serviced and group areas, such as laboratories and discussion areas are on

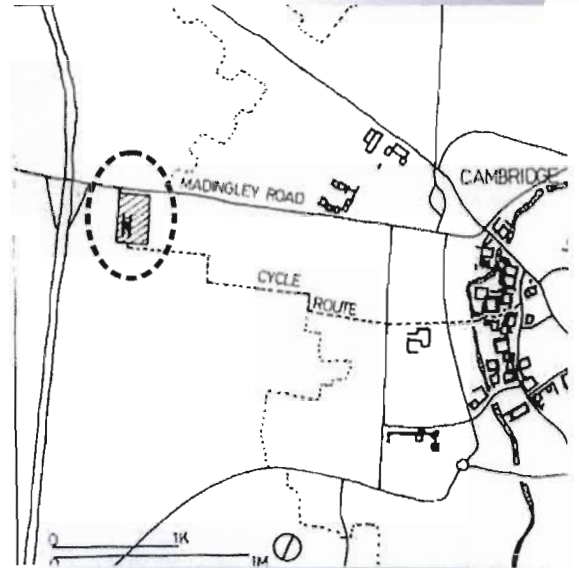


Illustration 4.3: Site and context. Schlumberger is located on university land to the west of Cambridge town.

Source: (Haward: 1984, 43)



Illustration 4.4: Winter garden containing restaurant.

Source: (Groák: 1985, 51)

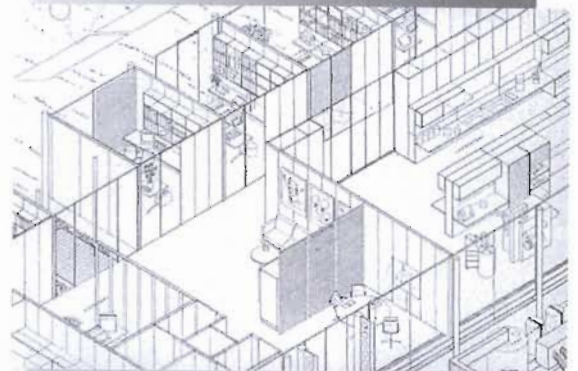


Illustration 4.5: Three dimensional sketch of areas butting onto test station. Laboratories and other group areas have views into the test station while private offices have views out.

Source: (Groák: 1985, 48)

the inner facing areas adjoining the testing station and winter garden. (ill 4.5 on previous page) The linear approach to the building allows for easy expansion. The modular approach to design incorporates the notions of flexibility and adaptability, but Hopkins emphasized flexibility (that being a physical rearrangement of the existing fabric, as opposed to adaptability which is the alternative use for given spaces).

In addition to the overall planning of the building, a strong sense of organization is followed through in section. (Haward: 1984, 42) The longitudinal section is organized so as to have service vehicles directly accessing the test station to the north at a lower level, while the general public access is on an upper level from the south. (ill 4.7 and 4.8) In cross section, this strong organization is also evident due to the accommodation layout as described above. (ill 4.9)

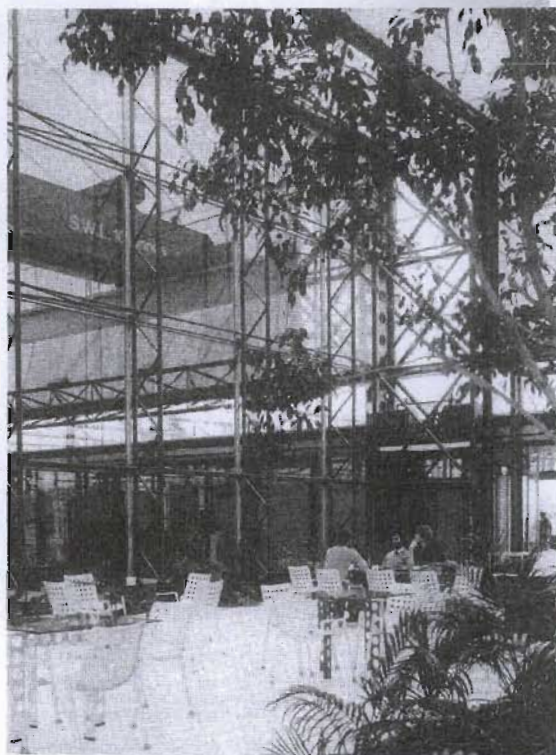


Illustration 4.6: View from winter garden. The test station operations are clearly visible from the restaurant.  
Source: (Groák: 1985, 51)

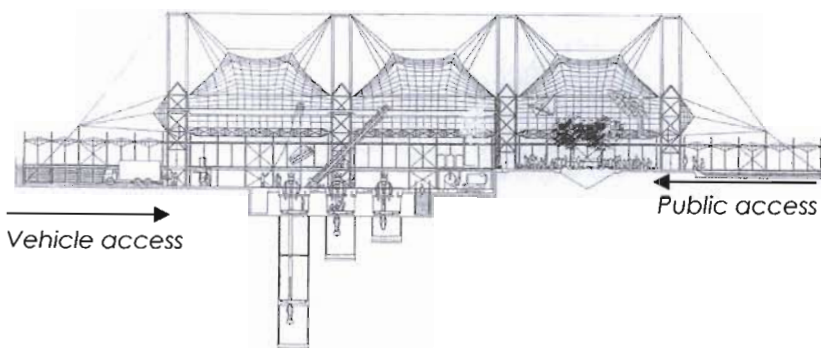


Illustration 4.7(left): Longitudinal section depicting the different levels of the test station and winter garden. Notice the service undercroft to the right of the sunken test station.  
Source: (Haward: 1984, 13)

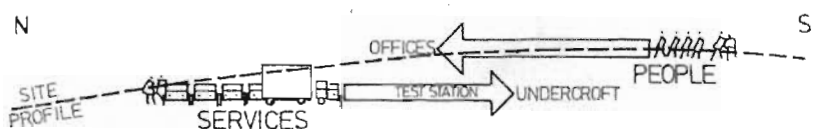


Illustration 4.8(left): Sectional strategy depicting the utilization of the slope to separate people and services.  
Source: (Haward: 1984, 43)

#### 4.2.4 Imagery and narrative

There are other particular concepts followed and implemented in the design that should be noted. Of particular interest is the user being presented with a narrative of the building. (Groák: 1985, 45) The users, function, and work outcomes of the building are, in essence, on display - this is achieved by applying layers of transparency. Users have a direct visual link between semi-public spaces such as laboratories, test stations, discussion rooms and the winter garden. (ill 4.6) The private spaces of the facility are placed on the perimeter and cannot be viewed from other locations.

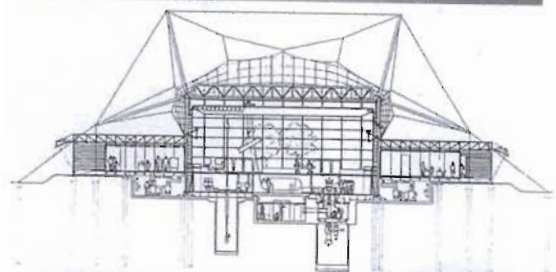


Illustration 4.9: Cross section through the test station. Laboratories with undercrofts face into the test station area, while offices face outward.  
Source: (Haward: 1984, 45)

Another noteworthy concept is the implementation of imagery appropriate to the oilrig. The palette of materials, the exposed structure and the junctions used belong appropriately to an industrial environment. Through the use of masts and cables, the imagery becomes appropriately linked with an oilrig. (ill 4.10 & 4.11) This imagery creates a synergy between a client searching for more efficient oil extraction and an architect searching for more appropriate materials and construction. (Hannay: 1985, 29) The decision to use certain materials was not made solely on their contribution towards the imagery, but was rather rationalized by practical considerations. (Herzberg: 1984, 49) An example of this is the use of the Teflon-coated membrane. It was selected as it is an inert plastic, highly resistant to chemical attacks, is not susceptible to discolouration with age and is unaffected by Ultra-Violet light. It has a translucent factor of 13%, which allows for more than adequate lux levels at desk height during working hours in the deep test station and winter garden modules. (ill 4.6)

#### 4.2.5 Service approach

The approach to servicing within the building is primarily based on the opportunity afforded by the slope of the site. A system of a suspended floor with services running in an undercroft was implemented, and runs along three sides of the perimeter of the test station. (ill 4.12) Services then enter the laboratories through purpose made outlets in the floor. The purpose made outlets could affect the flexibility of the laboratories in the future, as configurations would have to suit the pre-existing outlets. (Herzberg: 1984, 57) The servicing demand increased during the construction phase, and an allocation that was once considered generous has now become congested.

#### 4.2.6 Environmental impact reduction

Even though this building was constructed before environmental impact became the serious issue it is today, it still responds well to the need for environmentally sensitive design on a number of levels. Most of the minimisation of environmental impact results from strategies to reduce energy consumption used in regulating the internal environment due to the cold climate of the location. (Haward: 1984, 47) Only



Illustration 4.10: An off-shore oil rig, the imagery of which the Schlumberger Cambridge emulates.  
Source: (Stephens: 2007, n.p.)

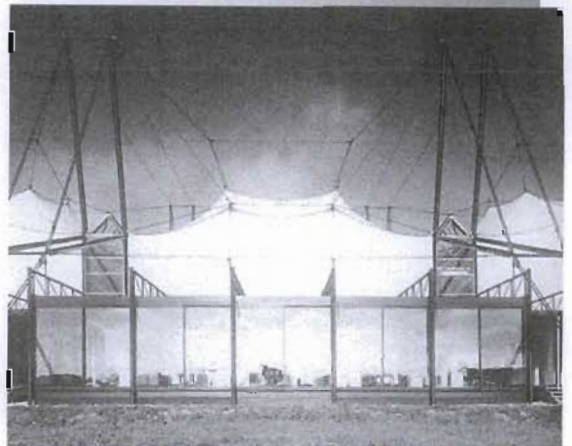


Illustration 4.11: The masts and cables used in construction have a visual echo with the rigging of an off-shore oil rig.  
Source: (Groák: 1985, 44)



Illustration 4.12: The servicing undercroft. During construction the servicing requirements increased, leading to the undercroft becoming congested. Servicing from below did however result in no structural modification due to change.  
Source: (Herzberg: 1984, 57)

areas that specifically require air-conditioning are serviced, the other volumes are naturally ventilated. The layout of the building allows for the air-conditioned laboratories and conference rooms to be 'insulated' by the volumes around them, and untreated air is drawn from the winter garden, which acts as an intermediary space. All of the elements of the building envelope are well insulated, primarily to reduce heat loss. The practice of having an exposed structure is also meant to respond to the minimization of environmental impact. It is said to reduce the required heating by reducing the volume that needs to be heated, but thermal bridging is a potential problem that needs to be addressed adequately. The exposed structure also reduces the area of cladding required. The translucent roof membrane provides for diffuse natural lighting into a deep space, and thus greatly reduces the need for artificial light.

#### 4.2.7 Conclusions

A holistic and rationalized approach to each decision made in the design approach can lead to an exciting, pleasant work environment that takes both functionality and the human dimension into account. Some of the successes of the building involve the approach to planning and appropriate use of materials. Particular aspects include:

- Planning informed by the topography.
- Placing appropriate building functions to benefit from the view.
- Planning that recognises and facilitates informal interaction and integrates different activities into the complex.
- Using materials that evoke a specific imagery and has environmental impact reduction benefits.

The overall success of the building is however compromised with the purpose formed service openings in the floor limiting flexibility.

### 4.3 The Salk Institute for Biological Sciences

Architects: Louis Kahn

Location: La Jolla, California, United States of America

Date: 1959

#### 4.3.1 Background

This building, more commonly referred to as "the Salk", is arguably the most famous medical research building globally. Commissioned by Jonas Salk in 1959, this Louis Kahn design was presented with the AIA's 25 year Award in 1992 as it "...goes beyond architecture into a mystic realm". (Crosbie: 1993a, 41) It is also ranked 19<sup>th</sup> in Architectural Record's 1991 poll of the 100 greatest buildings of the journals centenary. (Anderson: 1991, 136) Located in La Jolla, California, it is a masterpiece of architecture as it successfully embraces the metaphysical as well as being very functionally sound.

The building in its entirety is described as "...a square surfaced in travertine with a rivulet channelled straight down the middle to the Pacific [Ocean]. The parallel five story buildings, with windows angled towards the view, frame the plaza, sky, and vista with what seems a blank, serrated façade that directs perspective to a vanishing point just above the lip of the stream as it virtually pours into the Pacific." (Giovannini: 1996, 75) (ill 4.13) To most, it is the courtyard with the vista to the sea that is the quintessential component of the Salk, but it is still a well functioning, working laboratory accommodating 500 students, scientists and support staff.

#### 4.3.2 Client's brief

The brief called for the accommodation of 10 major scientists, each requiring approximately 930m<sup>2</sup> of laboratory space. There was to be provision for the expansion of each research group, and the laboratory spaces were to be supplemented by study spaces. The initial brief included residences and a meeting house, but these were later excluded due to budgetary constraints; this resulted in a design that accommodated laboratories, administration and a library in mirror image blocks of three stories interspersed with three stories of service space. (ill 4.15 on following page)

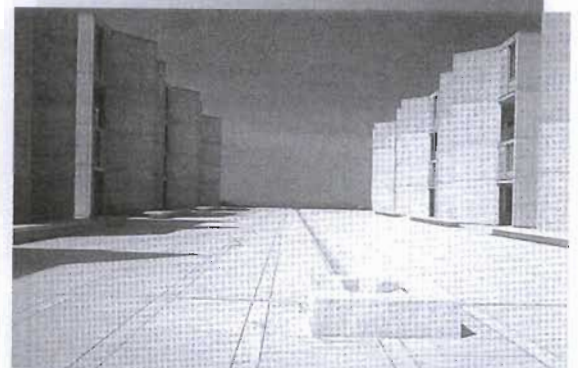


Illustration 4.13: The upper courtyard of the Salk, the 'facade to the sky'. It terminates with an unhindered view to the Pacific Ocean and incorporates a rill down the centre of the courtyard.

Source: (Treib: 2006, 403)

The major concept of the design had to do with the way in which scientists think, work and live. Jonas Salk was of the opinion that scientists arrive at most of their ideas through osmosis, therefore the concept of fostering communication was important. (Crosbie: 1993a, 44) The translation of this concept resulted in open laboratories (ill 4.14), enabling the sharing of equipment and ideas between researchers, and informal discussion places, such as stairways and courtyards designed to facilitate this interaction. The concept of a scientific cloister was also put forward by Salk, as he wished to replicate its sense in the laboratories. (Crosbie: 1993a, 43) This concept translated into the two wings of the building framing the courtyard and offices facing into it. (ill 4.15)



Illustration 4.14: The open plan laboratory space without any equipment or benches. Servicing is from the slots in the ceiling. This allows for maximum flexibility, which the Institute laboratories are praised for. Subsequent plans show that it is subdivided, thus indicating that such a large area is not a necessity.

Source: (Crosbie: 1993a, 40)

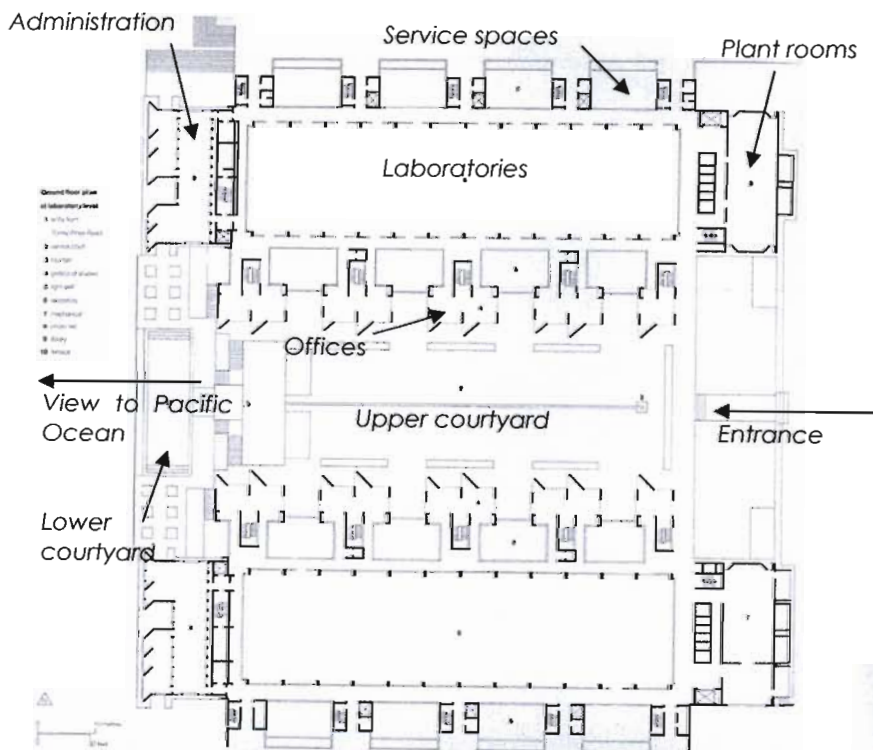


Illustration 4.15: Ground floor plan. The two wings of laboratories with support spaces border the plaza to the north and south. There is a very deliberate hierarchy of space emanating from the centre, the plaza.

Source: (Crosbie: 1993a, 42)



### 4.3.3 Treatment of spaces

There is a suggestion that Kahn was a generalist, being that he followed the concept of fully integrating building technology, architectural function and human space. (Leslie: 2003, 97) The translation of this resulted in an intensity that Kahn applied to system, materials and methods which ultimately led in part to the power of the experience that the building evokes.

The treatment of the courtyard as a plaza resulted in the famous 'façade to the sky'. With its unimpeded channel, one's sight and soul is directed to the sea, which view is the western termination of the courtyard. This place is a spiritual rather than a physical amenity as the exposed nature and surface treatment results in physical discomfort during the day due to the heat and glare that characterizes it. (Treib: 2006, 414) The courtyard was initially supposed to be a 'common living room', but it is the least used exterior space due to the physical discomfort. During the design and construction process, it evolved into a space with a strong metaphysical aspect that inspires the individual somewhat at the expense of the community. (Treib: 2006, 422) This evolution nonetheless has resulted in the place having a powerful impact on the individual and is successful as "*Scores of people visiting the courtyard over the years have been struck by its strength, simplicity, elegance and focus.*" (Treib: 2006, 422)

In terms of usability and providing a space that is the 'common living room', the lower courtyard next to the cafeteria is more successful. (ill 4.16) Its success as a comfortable place to relax is attributed to the fact that this human-scaled area enjoys filtered natural light, is a nearby respite from the laboratories, and enjoys a comfortable measure of privacy. The users of the space can modify the courtyard to their individual needs as there are movable seats and umbrellas, and the setting is enjoyable with a panoramic view of the Pacific Ocean.

### 4.3.4 Planning resolution

The planning of the overall building revolved around the accommodation being positioned to flank the building's "soul", the courtyard. Within the two wings are the three levels

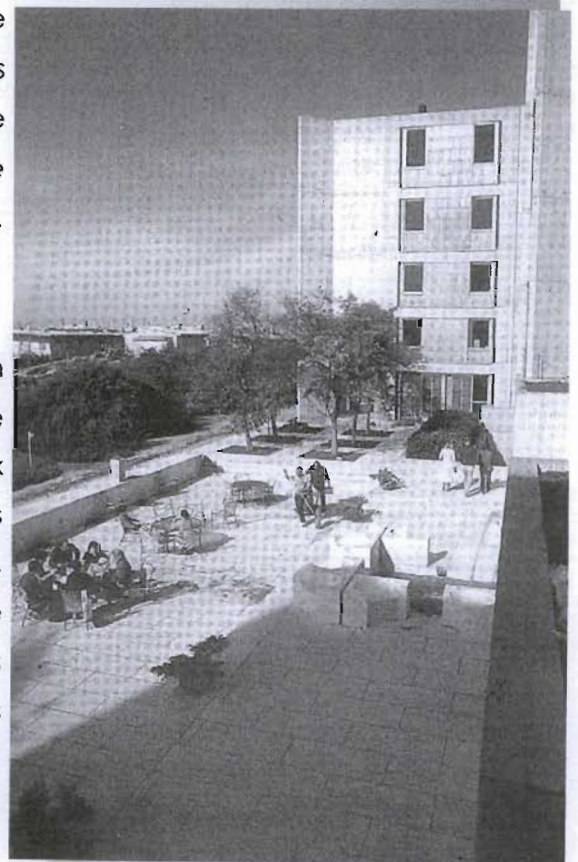


Illustration 4.16 (left): The 'lower courtyard'. Due to its greater level of amenity and flexibility, it has become the 'common outdoor living room'. Source: (Treib: 2006, 413)

of open laboratories with their three levels of interstitial service levels. (ill 4.19 on following page) The laboratory design was ground-breaking as it introduced open spaces, modular planning, ease of communication between scientists, easily reconfigurable utilities and services, and cantilevered laboratory benches. (Crosbie: 1993a, 42) These 75m by 20m clear span laboratories have a clear height of 3.35m which allows for easy changes in equipment and layout to be made. The interstitial spaces act as storage for bulky and noisy equipment as well as for servicing, and this has resulted in a more compact laboratory environment and hence more interaction between scientists. The overall planning of the laboratories has scientists praising it for its flexibility.

There is a deliberate hierarchy of spaces in the planning, emanating from the courtyard, and progressing outwards in a linear manner. The progression has the private and individual 'cells' of the cloister – the scientists' offices – flanking the courtyard and inflected towards the view of the sea. The offices are then followed by the mediated realm of the laboratories. 'Serving' spaces, such as stairs and ablution facilities are specifically placed to the outer sides of the laboratory wings. (ill 4.15)

#### 4.3.5 Service approach

The servicing of the laboratories is the main component of the building's functional success. Louis Kahn had a specific approach to it.

*"I do not like ducts; I do not like pipes. I hate them really thoroughly, but because I hate them so thoroughly I feel they have to be given their place. If I just hated them and took no care, I think they would invade the building and completely destroy it." (Louis Kahn in Leslie: 2003, 95)*

His particular treatment of that which he hated so thoroughly resulted in the interstitial space that contained the mechanical systems and utilities of the laboratories being structurally composed of a 2.75m high Vierendeel truss spanning 20m (ill 4.17), allowing for a flexible column-free space below. (ill 4.18)

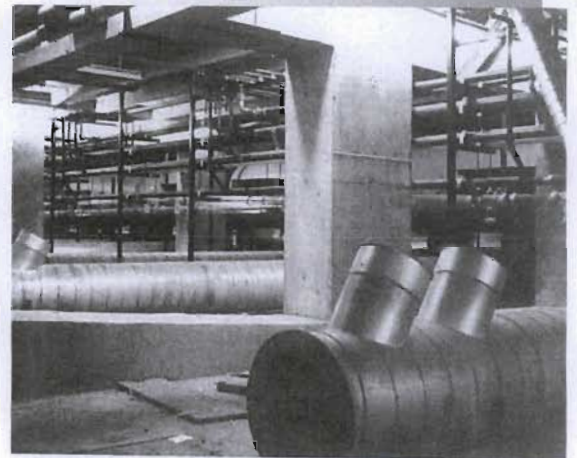


Illustration 4.17: The 2.75m high Vierendeel truss structural system allows for services to easily be run through its voids, and provides for adequate space for their ever changing requirements

Source: (Leslie: 2003, 103)

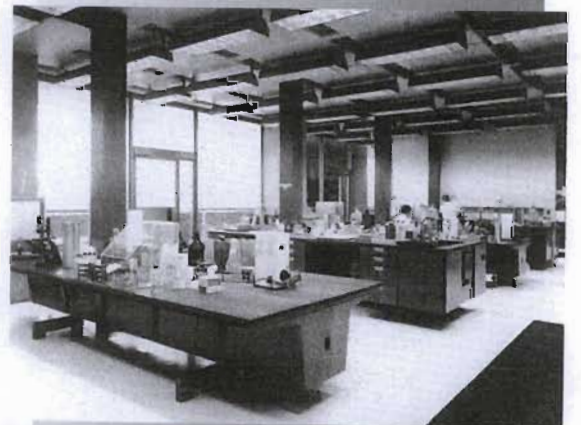


Illustration 4.18: The fully equipped laboratories with cantilevered benches. The vertical elements to the left of the benches are temporary trunking.

Source: (Leslie: 2003, 104)

The inclusion of the interstitial spaces allows for the modification of services to almost any configuration without disrupting the laboratory space below. It adds considerable volume to the overall building, but "six floors of interstitial service space, nine feet [2,75m] high and once considered extravagant, have come into their own." (Benedikt: 1993, 53)

#### 4.3.6 Structural system

The development of the Vierendeel truss structure led to an efficiently designed section. (ill 4.19) To reduce the bending moment, the truss is cantilevered at both ends, and this practical consideration then provided for walkways for moving equipment and shading for the glass walled laboratories. The 'porosity' that the voids in the truss create allows for services to easily run perpendicular to the truss and it frees up the floor slab of the interstitial space for service drops. The major pipes are located in the centre of the space where the voids are greatest, while the components that require the most maintenance are located closest to the service corridors. The interstitial spaces are connected vertically at the east end of each block in a 'mechanical wing'. Chillers, air handlers, liquid and gas services and equipment are based here. These 'mechanical wings' are connected underneath the raised wall of the courtyard.

#### 4.3.7 The metaphysical aspects

One question should be asked in relation to 'the Salk'. Though functionally sound, are the metaphysical aspects of the building relevant? Is iconic architecture relevant to scientific achievement? Some researchers based at the building respond that some of the best scientific work is done in appalling conditions, and that though they are aware of the iconic architecture around them, they don't consider it essential. Others do concede that a building could affect a scientist and their personal experience is that the building lifts their spirits. (Crosbie: 1993a, 44) These individuals do not specifically make a link between a good architectural environment and their work productivity, but the old adage surely applies: 'a happy worker is a productive worker'.

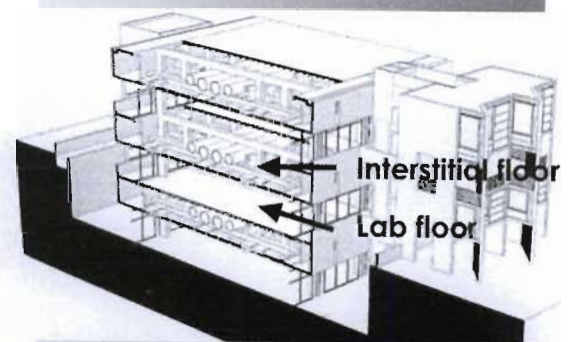


Illustration 4.19: Cutaway section showing the interstitial space formed by the Vierendeel truss creating three stories of service space serving laboratories below.  
Source: (Leslie: 2003, 111)

#### 4.3.8 Conclusions

The overall success of the building as not only a functional research laboratory, but also as an icon of American Modern architecture can be attributed in part to the following:

- An acknowledgement of holistic place-making, where individual aspects are treated in relation to their contribution to the whole presence and experience of the building.
- The integration of natural features, such as the view to the Pacific Ocean
- The exploitation of functional requirements in a rational way to benefit the overall scheme, such as the use of Vierendeel trusses to provide service spaces and cantilevering slabs to shade walkways. In this instance the full professional team requires acknowledgement as the engineering and laboratory consultants were as important in the design process as Kahn was.

*"In their multi-valence, these systems attest to the balance achieved between function, constructional efficiency, structural performance, and human perception, a constant process of revelation and explanation, and a perpetual shrinking of the distance between our contingent experience and the platonic realm of Order." (Leslie: 2003, 110)*

Some concerns in the design of 'the Salk' include:

- The potentially inappropriate treatment of the upper courtyard, thereby frustrating the initial intended usage of the space
- The separation of the facility into two distinctive wings. This reduces the intended interaction sought between individuals from one wing with the other.

#### 4.4 The Neurosciences Institute

Architects: Tod Williams Billie Tsien Architects

Location: La Jolla, California, United States of America

Date: 1995

##### 4.4.1 Background

The Neurosciences Institute (NSI) moved to La Jolla, California at the invitation of the Scripps Research Institute in the mid 1990's. Though an independent organization, Scripps funded the majority of the construction for the complex and leases it to the NSI. The architects Tod Williams and Billie Tsien worked primarily with the institutes' founder and director Gerald Edelman in the design of the 5200 m<sup>2</sup> complex. By comparison to the Salk, located about a kilometre away, this is a small venue for no more than 12 visiting fellows at one time, allowing for unfettered exchanges between scientists. This exchange is the project's strongest programmatic requirement. Edelman's own scientific research in neurobiology influenced the design process with his revolutionary ideas about how the human mind functions. (Freiman: 1995, 76)

##### 4.4.2 Client's brief

Edelman wanted a sense of commitment to excellence and artistic vision to be embodied by the design. This was achieved by the architects creating the non-formal cloister design (ill 4.20) using Edelman's theory that the brain develops by natural selection with certain signals favoured over others, that are then strengthened and adapted to satisfy a physical or psychological need. It was thought that the cloister approach would encourage 'experimentation and discovery'. This theory resulted in there being no single way of experiencing the entire precinct, but that it is revealed in portions from walkways, balconies and stairs. (Dietsch: 1996, 88) (ill 4.21) "This small research facility successfully distills the brain's evolutionary nature into a scientific monastery that encourages multiple interpretations." (Giovannini: 1996, 73)

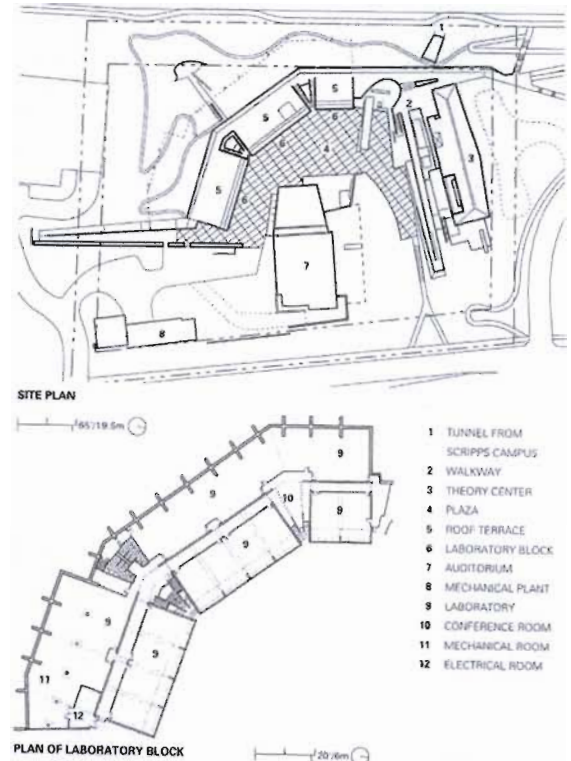


Illustration 4.20: Site plan and plan of the laboratory block. In reaction to Salk's formal courtyard, the architects instead favoured a more 'humanist' approach and implemented a non-formal cloister concept to the complex. Source: (Dietsch: 1996, 87)



Illustration 4.21: Unlike the 'Salk', the building is not 'monumental' in its execution; rather elements are revealed as one moves through the complex. Source: (Dietsch: 1996, 86)

#### 4.4.3 Design elements

Though the building is closely located to Salk and also applies the concept of a scientific cloister, Williams and Tsien rejected the symmetry and frontality of Kahn's design (which they characterized as 'oppressive' and inappropriate) and favoured a more site-specific architecture conducive to social interaction. "Our whole thought about making places is that people can enter them without destroying the clarity of space." (Billie Tsien cited in Freiman: 1995, 77)

#### 4.4.4 Planning resolution

The complex is designed to nestle into the hillside across from the Scripps campus and is linked to it by a tunnel. Two distinctly different types of scientists – theoreticians and empiricists – occupy the building and they are treated differently architecturally. Theoreticians are 'lofty thinkers', therefore the theory centre is treated as a volume elevated on a glass podium. (ill 4.22) Empiricists are 'grounded', therefore their accommodation is treated as a semi-basement. (ill 4.23) In addition to these two buildings, a meticulously planned auditorium, which is a premier concert venue, defines the plaza edge to the west. These separate buildings define the winding plaza and roof walkways, which translate into the latter-day cloister. This forms an integral part of the institutes' humanist culture. "The space between the buildings is the foundation of our design" (Tod Williams cited in Dietsch: 1996, 91)

#### 4.4.5 Courtyard comparison

A comparison has been made between the main courtyard of the Salk and the plaza of the NSI. The Salk's elevated court is symmetrically framed. This concept was dismissed by the NSI architects as it added to the overall 'oppressiveness' of the Salk's courtyard, they rather opted for an irregular sunken plaza. The focus of the courtyards differ too, the Salk's courtyard is directed outwards to the Pacific Ocean view, while the NSI's is introspective. Kahn maximised the opportunity of the view to the ocean, but this opportunity was not available to Williams and Tsien. Added to this, they had to contend with the possibility of visual encroachments from the



Illustration 4.22: The theory building is situated on a glass ground floor to give the appearance of it 'floating' in response to the way theoreticians operate.  
Source: (Dietsch: 1996, 90)



Illustration 4.23: The laboratory block, where the 'grounded' scientists work. The junction between the buildings is treated as a public space in itself.  
Source: (Freiman: 1995, 80)

expansion of the Scripps Institute. The Salk courtyard embodies 'a timeless universality', while the NSI 'posits a temporal site specificity.' (Freiman: 1995, 79)

#### 4.4.6 Materials

The formal and cold palette of building materials, comprising items such as concrete and fossilized limestone, are humanized with meticulously crafted elements such as redwood accents and door handles to fit the hand, and a mysterious stone slab cantilevered from a balcony. (Dietsch: 1996, 92) (ill 4.24) This limited palette was modified to have tactile and textural diversity and variegated colours with assorted finishes being applied. Glass, and concrete was sandblasted; stone was honed, cleaved and polished.

#### 4.4.6 Conclusions

Though based on similar principles to the Salk, the Neurosciences Institute departs radically in the following manner:

- It does not give the same weight to purity and metaphysical aspects.
- The organic approach and sensitivity to issues of scale and treatment of materials seems to create a more user friendly public space that facilitates interaction.
- It takes cognisance of the differing types of individuals involved in research at the institution.

*"Expressive of the intuitive and intellectual, this remarkable architecture of humanism profits art and science alike."*  
(Dietsch: 1996, 92)



Illustration 4.24: 'Humanising' touches have been added all round the complex, such as redwood surfaces.

Source: (Dietsch: 1996, 91)

#### 4.5 Extension to The Salk Institute

Architects: Anshen & Allen Architects

Location: La Jolla, California, United States of America

Date: 1996

##### 4.5.1 Background

David Rinehart and John MacAllister had the unenviable task of designing the additions to one of the greatest examples of Modernist architecture in America, Louis Kahn's Salk Institute. The complex brief can be summed up as follows:

*"The fundamental design problem was not so much the new complex as a building, but how the building shaped its own open space and the space leading to Kahn's worldly and other worldly plateau." (Giovannini: 1996, 75) (ill 4.25 & 4.26)*

From the formal unveiling of the design in 1991, this was a highly contentious project, mainly revolving around the additions disrupting the 'sacred' grove of trees that pre-empted the entry into the upper courtyard of the Kahn building. The 10 000m<sup>2</sup> addition of laboratory spaces, administration offices, auditorium and visitor's centre has been described as highly literate, modestly scaled, and referential and deferential in mass, orientation and language to Kahn's building, but became design shy from many critics. (Crosbie: 1993c, 50)

In essence, the controversy stems from there being two competing perspectives on the architectural process. Firstly, there is the general public's perspective; and secondly, the users of the building. (Benedikt: 1993, 53) The public views a masterwork and their perspective is focussed on the unique place in history the building holds. On the other hand, the users are intimately aware of the working of the building, they know its inadequacies and dream of solutions to it. This does raise an interesting side question, whose needs and opinions take precedence in the architectural realm? The controversies surrounding the design are a quagmire, therefore most of it will

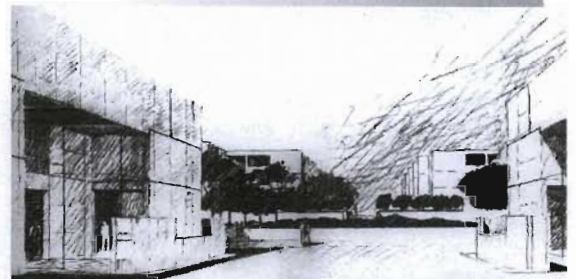
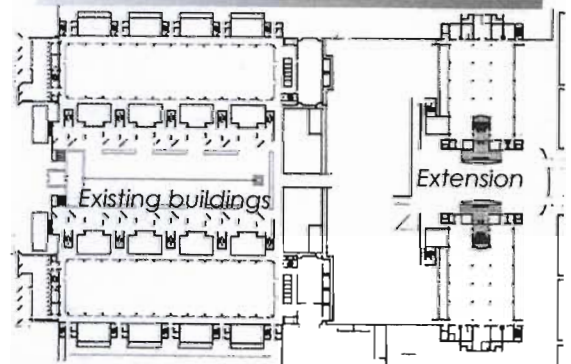


Illustration 4.25: Architect's sketch depicting the link between the extension and Kahn's building in the background.  
Source: (Crosbie: 1993c, 48)



FINAL SCHEME - OCTOBER 1992

Illustration 4.26: Plan of the extension (to the right) in relation to the original Salk Institute building. Kahn's North / South axis has been extended.

Source: (Giovannini: 1996, 74)



be avoided and the research will focus on the practicalities of the building.

#### 4.5.2 Planning resolution

The building consists of two wings designed on a north – south axis with two upper levels and a basement level that links the two wings with a generous lobby to the auditorium space. (ill 4.27) Laboratory spaces are to be found in the basement and top floor, with administration being located on ground floor. Mechanical spaces are found on the outer edges of the two wings, resulting in the primary spaces having glazing to the east and west. The two wings are separated by a plaza that continues the space of Kahn's main plaza. (ill 4.26)

#### 4.5.3 Functional flaws

Critics, aside from those who are concerned about the 'intrusion' of the 'sacred space' that the addition would have, have practical observations about the addition. Though the scientists that occupy the space are not all that concerned over the 'intrusion', they will most likely be quick to respond to the functional flaws in the building that impedes their work. These functional flaws are summed up by Crosbie (1993c, 50) as such:

- Intermediary structural columns have been included within laboratory spaces. (ill 4.27)
- The 2,1m high interstitial top floor is insufficient to house some equipment.
- The basement laboratory has no interstitial space, and though it is intended as a dry laboratory, mechanical systems will be routed across the ceiling.
- The basement laboratories do not have access to natural light.
- The basement and top floor laboratories do not have direct access to offices or meeting rooms.
- The top floor laboratories are insufficiently protected from direct east and west sunlight. (ill 4.29)
- The stairways are not generous and do not facilitate interaction. (ill 4.30)
- The two laboratory floors are separated by an administration floor. (ill 4.28)

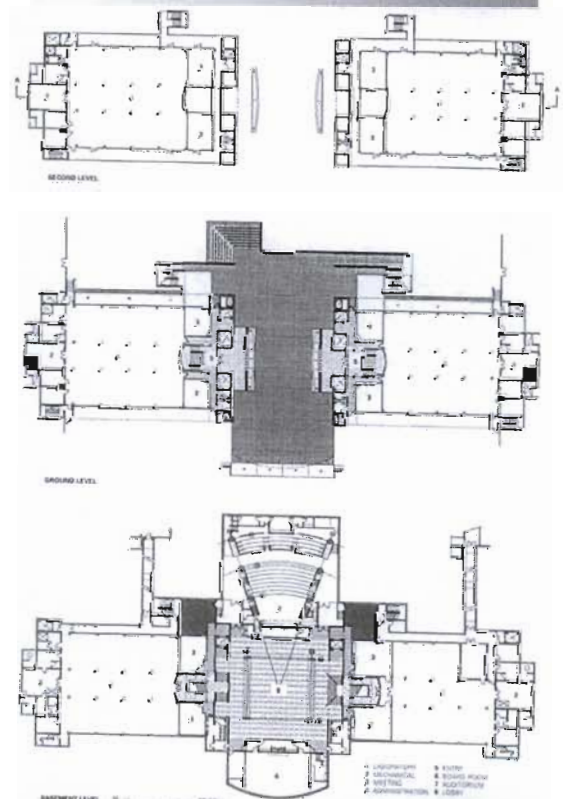
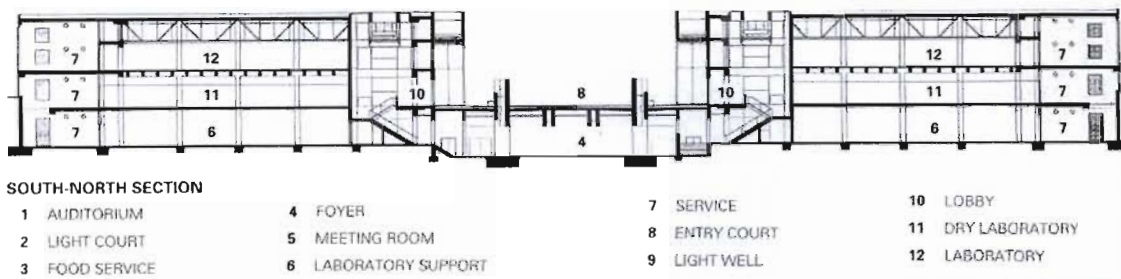


Illustration 4.27: Plans of the building. The major accommodation has openings facing east and west.  
Source: (Crosbie: 1993c, 51)



*Illustration 4.28: Cross section through the building. Notice that there is only one story with a dedicated service space, there are no light wells to below grade laboratory spaces and, according to texts, the two laboratory levels are split by a level of administration, though in this section it is indicated as a dry lab level.*

*Source: Giovannini: 1996, 75]*

Where Kahn's building managed to seamlessly integrate function into the metaphysical place, the Salk additions are surrounded by serious practical reservations. Servicing, circulation, and planning all seem to have been compromised in the design. It may be unfair to blame the architects entirely for this. When comparing the two Salk buildings, one must remember that the changed program, budget, client and the more businesslike and computerised approach to research each have had their influence. (Benedikt: 1993, 54)

#### 4.5.4 Conclusions

There are many reservations with the design of the building. Generally, these have resulted due to the attempt to aesthetically blend in with the original 'Salk' building. These include:

- A structural system that does not facilitate flexibility.
- The overall planning that does not facilitate interaction.
- Insufficient service space allocation.
- Environmental impact reduction strategies that do not sufficiently work.



*Illustration 4.29: Most of the glazing faces east or west. As seen above, the steel screens shading the west façade of the building do not sufficiently protect the laboratory spaces from direct sunlight in the early morning or late afternoon.*

*Source: (Giovannini: 1996, 76)*



*Illustration 4.30: Circulation spaces are not conducive to informal discussion. This exterior passageway has no bleed of space.*

*Source: (Giovannini: 1996, 76)*

#### **4.6 Overall conclusions drawn from precedent studies**

Though all of the precedent studies researched are unique in their own right, certain general conclusion regarding medical research facilities can be drawn for them. These conclusions should be seen in light of identifying important concepts and the implementations thereof as a guideline to follow. Some identical concepts have been translated into different solutions in different schemes, some with greater success than others, and these should be evaluated against the specific project conditions. Those which have been identified include the practical aspects of servicing, structure, planning and environmental impact, and the transcendent such as imagery and the creation of an environment sympathetic to human habitation.

##### **4.6.1 Site**

- Opportunities in respect to views, orientation and topography that the site offers should be utilized.
- Noteworthy views should be maximised by allowing for the greatest human exposure to it, as appropriate.
- Spaces should face appropriate orientations. By doing so, human comfort can be increased and energy consumption for environmental control within the building could be minimised.
- The topography facilitating servicing should be investigated.

##### **4.6.2 Servicing**

- The building's flexibility is inextricably linked with servicing; therefore an appropriate response is crucial.
- Servicing by means of outlets from above rather than below is generally more appropriate.
- Vertical runs, such as at Kahn's Richard's Medical Research Laboratories at the University of Pennsylvania, has its limitations as only spaces directly adjacent to vertical ducts are easily serviced.
- Service spaces and plant rooms should be adequately sized to allow for decentralization and include spare

capacity to easily accommodate increases in service requirements.

#### 4.6.3 Flexibility

- Spaces should be designed to allow for minimal disruption when they are modified.
- Spaces designed to a specific module size allows for changes to be effected easily and without much disruption.
- Interstitial floors allow for maximum service flexibility, but are expensive to implement.
- Overall building flexibility can be facilitated by the ability to be easily extended.

#### 4.6.4 Planning

- The building should be functionally sound.
- The work environment should be planned to be vibrant and innovative.
- The overall environment should be alive with use.
- Circulation should be designed to facilitate informal interaction.
- Building technology, architectural function and human space should be fully integrated.

#### 4.6.5 Physical environments requirements

- Opportunities for providing required conditions, such as lighting and ventilation levels, should be met by natural means where appropriate.
- The required environmental conditions of exterior spaces should not be neglected. Spaces may require protection from the elements.

#### 4.6.6 Environmental impact

Simple planning principles can be implemented to reduce environmental impact at minimal cost. These include the principles of:

- 'insulating' spaces;
- implementing natural lighting where appropriate;
- reducing areas requiring artificial climate control;
- designing an efficient building envelope; and
- shading of openings.

#### 4.6.7 Facilitation of human processes

Building on Jonas Salk's notion that scientists get their ideas through osmosis, it seems important that informal as well as formal interaction be accommodated. This can be done by:

- having open planned laboratories;
- allowing for generous stairs and passageways;
- placing facilities in a manner that will lead to interaction;
- providing spaces in scales of privacy, from the widening of a section of passageway to the inclusion of small seating areas; and
- providing break-away spaces.

In addition, the overall environment can be made more sympathetic to human habitation by:

- Adding crafted elements to mitigate a cold material palette;
- Including tactile and textural diversity to finishes; and
- Integrating the natural environment in the complex.

#### 4.6.8 Imagery

Though differing opinion will always be available regarding the appropriate imagery of a medical research institute, the application of decisions related to materials, forms, finishes, and the like need to be integrated. A synthesis between the design and the work product within can be achieved by the structural system implemented, junctions used or materials chosen.

#### 4.6.9 Concluding remarks

A rational approach needs to be followed by fully integrating building technology, architectural function and human space in the design process. Opportunities exist in all decisions for choices that are ingenious solutions to a variety of considerations rather than a solution for a specific problem. In a highly functional building, one must not lose sight of the most important component of the building, the people that use it.

## **Chapter 5 - Case studies**

### **5.1 Introduction and selection rationale**

Though this research is aimed at the design of a medical research institute, only one case study will deal specifically with medical research, namely the Doris Duke Medical Research Institute based at the University of KwaZulu-Natal Nelson R. Mandela school of Medicine. Investigations did not reveal any other facility of its nature in the KwaZulu-Natal Province; therefore other non-medical research-based case studies were selected to examine principles that will apply to research facilities in general. The Council for Scientific and Industrial Research (CSIR), Durban campus, and the Physics and Chemistry Laboratories housed in the Block H building at the University of KwaZulu-Natal, Westville campus, will be the other two case studies. These still give invaluable insight into the research environment and process in addition to servicing and other practicalities of the buildings. The lack of other medical research facilities does seem to reinforce the practical need for a new facility of this kind.

The areas that will be focused on in the examination of the case studies have been determined by the findings of the precedent studies, as presented in the overall conclusions of the previous chapter. Where appropriate, the buildings will be analysed by the following criteria: siting; servicing; flexibility; planning; physical environmental requirements; environmental impact; the social component and imagery. The analysis will be carried out with a combination of an examination of drawings and images; interviews with architects, facility users and other associated parties; and the application of findings from the previous chapter.



**Case Study 1:** Doris Duke Medical Research Institute, Nelson R. Mandela School of Medicine, UKZN



**Case Study 2:** CSIR Durban Campus



**Case Study 3:** Block H Laboratories, UKZN Westville Campus

**5.2 Doris Duke Medical Research Institute**

Architects: Robert Johnson Architect and Associates; FGG Architects; Langa Makhanya Architects; and East Coast Architects

Location: Nelson R. Mandela School of Medicine, University of KwaZulu-Natal.

Date: 2001 – 2003

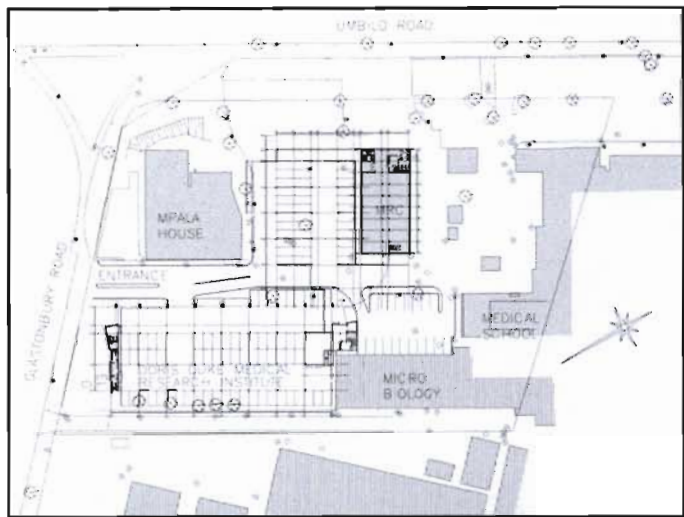


Illustration 5.1: A site plan indicating the ground floor parking of the Institute in relation to surrounding buildings. The existing buildings on site resulted in a restrictive area for the new development to be built on.  
Source: East Coast Architects

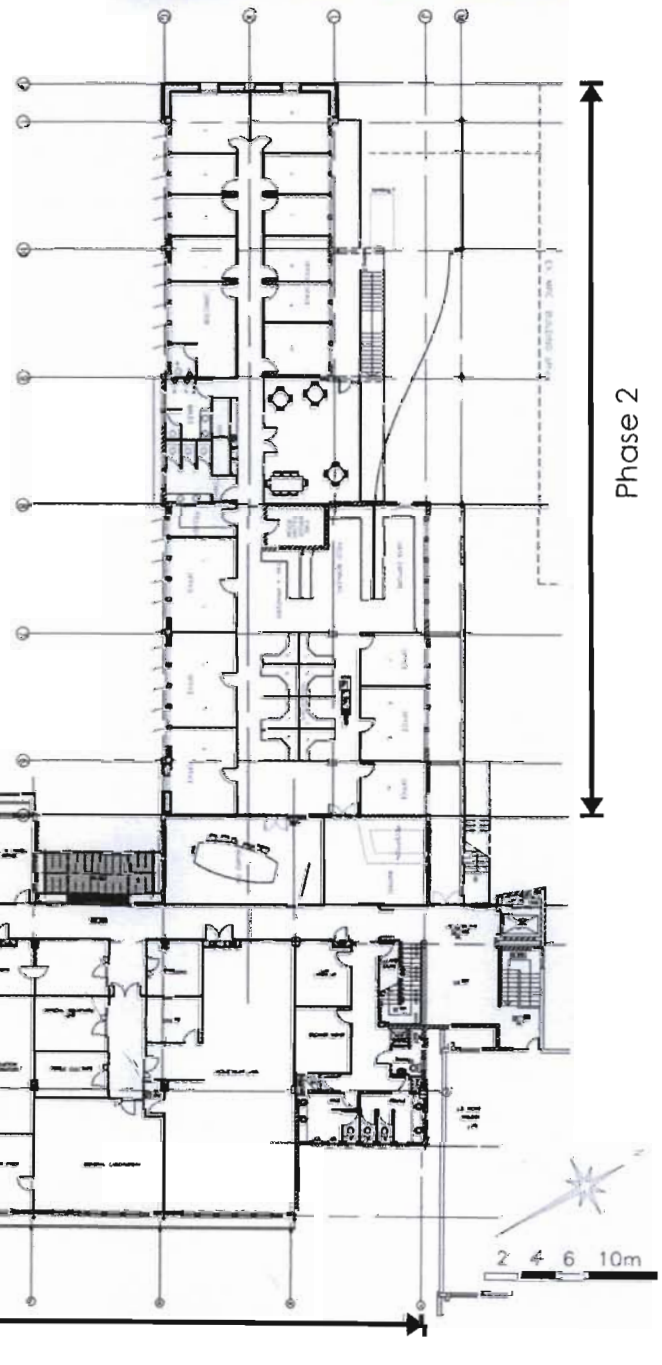


Illustration 5.2: The 2<sup>nd</sup> Floor plan depicting both Phase 1 and 2. Phase 1 is typically a serviced shell. The partitions of the laboratory spaces were planned at a later stage to the structure. The three protruding bays on the west of the administration and other support functions to the laboratories. Space is quite tight, and many staff members share office space. This high staff to floor area ratio makes break away spaces that much more important.  
Source: East Coast Architects

### 5.2.1 Background

In the press statement, 'Launch of a R40 million Research Facility' (University of Natal, June 2003), Professor Barry Kistnasamy stated that the founding principle of the Doris Duke Medical Research Institute (DDMRI) is to provide "...a dynamic and integrated research environment for inter- and multi-disciplinary medical research among basic, laboratory, clinical and public health scientists." The role that its construction and operation plays is that "...this research institute, together with public and private sector involvement, is pivotal to further improvements in the health status of [the South African] population."

The current 5 000m<sup>2</sup> building was constructed in two phases: phase 1 being the laboratory component consisting of 10 specialised laboratories accommodated over two floors (ill. 5.4 on following page); and phase 2 being the support functions such as administration, seminar, multi-disciplinary research centres and clinical trial spaces accommodated over three floors in a linking structure. (ill. 5.2) The third phase that would connect the research institute to the existing Medical Research Council building on site has been indefinitely postponed due to funding restrictions.

As with all of the precedent studies, one of the major concepts of the building is a consolidation of research facilities into a single environment where researchers from different projects have the opportunity to formally and informally interact with each other. The theory is that this cross-disciplinary interaction will result in advances in the respective individual research projects. (Kisbey-Green: 2007, Watch: 2007, n.p.) The success of this concept is not based primarily on research groups and their associated facilities being in proximity to each other, but rather by the opportunities to interact in the communally mediated spaces, such as corridors and break-away spaces. (ill. 5.3) These spaces for informal interactions created a duality in this particular project. The architect's concern for the inclusion of an appropriate amount of 'human space' – a place to sit and relax – to facilitate the all important informal interaction was not seen as important by the 'client', who



Illustration 5.3: One of many small exterior break-away spaces. Movable square tables and chairs make the space flexible which adds to the success of these types of spaces



could not see the benefit in these spaces, especially in light of a restrictive budget. This resulted in that break-away spaces were curtailed. (Cahi: 2007)

### 5.2.2 Site and general planning

The available space to construct a new development on the Medical School campus was restrictive. (ill. 5.1) The laboratory building occupies a narrow strip of the site in the south corner, close to the entrance; therefore its major façade faces west. In the design of Phase 1, the laboratory building was divided into three equal bays with decks in between, allowing for the easy attachment of Phase 2 to any one of the bays at a later stage. The lack of parking in general on the campus resulted in the building being raised on pilotis to accommodate parking beneath it. (ill. 5.4)

The general planning of the two phases can be summed up as simple and functional spaces interspersed with 'playful' elements. Laboratory and offices spaces are on the whole standard in design, but the uniqueness of the design comes in with the 'significant insignificants'. (Cahi: 2007) Here, the 'architectural follies' mediate the generic accommodation, so that the playful elements such as the lobby (ill. 5.5), fire escape stairs and social spaces contrasts with the functional laboratories and office spaces to create a building that generates some interest out of a brief that has the potential to become mundane due to the regimented functional requirements. The playful elements lend character and identity to the building while creating an overall pleasant environment to be in.

In Phase 2, due to budgetary and site restrictions, more than the average number of staff needed to be accommodated in the constructed office space, thus resulting in tight spaces. It is quite common to find three to four people working in a space that would be considered comfortable for only two. There are benefits to the tight accommodation, as staff working on the same or similar projects occupy a common space and can interact easily. What this does highlight is that there is a need for the office component to be well designed to take into

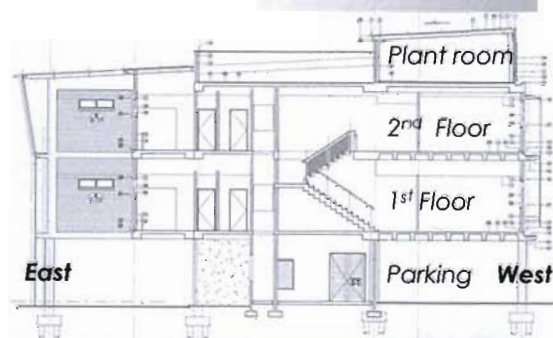


Illustration 5.4: Cross section through the laboratory building. The building is raised on Pilotis with parking underneath and plant rooms are located on each bay  
Source: East Coast Architects



Illustration 5.5: Main entrance lobby. Elements such as railing and skylights are playfully executed. Of interest is that the skylight structure has a parabolic shape.

consideration such things as partition layout; door placement and swings; placement and choice of air conditioning outlets; housing of shared functions such as network printers; the need for adequate filing and supply storage and the like. What this tight arrangement does result in, is the need for adequate spaces for private meetings and break-away spaces so as not to disturb other staff who share an individual office. A few small meeting rooms (ill. 5.6) and the outdoor space (ill. 5.7 & 5.8) facilitate the functional requirements of the office well while reducing the overall footprint.

This particular need for outdoor spaces is also echoed in the laboratory phase, where staff need a space in close proximity to escape to as the laboratory environment does not allow for activities not related to the actual process of researching, such as having a cup of coffee or taking a phone call. (ill. 5.9) In addition, the laboratory spaces are generally deep and subdivided, with the open laboratory space span being approx. 16m, thus isolating the researcher from the exterior environment. This makes the break-away spaces all the more welcome. These exterior spaces are described as the triumph of the Institute. (Kisbey-Green: 2007) The success of many of these spaces seems to be a combination of their proximity to other functions, their overall size, the flexibility of the space with movable furniture, and the amenities that are provided. These findings seem to reinforce those of the lower courtyard of the Salk Institute discussed in the Precedent Studies chapter.



*Illustration 5.6: A small meeting room. With staff sharing offices, there needs to be a venue for dedicated meetings so as not to disturb other office occupants.*



*Illustration 5.7: Kitchen counter of the major exterior break-away space. Water coolers & Hydroboils come highly recommended. The open nature seems successful.*



*Illustration 5.8: Movable square tables and chairs can easily be reconfigured to suit user requirements. Artistic details add to the relaxing atmosphere.*



*Illustration 5.9: The decks to the laboratory building provide the much needed break away space. Of interest is the seating integrated into the railing in the background.*

### 5.2.3 Circulation

There are some concerns about circulation and movement within the building. The extruded nature of this laboratory building due to the site constraints results in a long corridor within the laboratory building, and at one stage the stairs at the south end were to be used for emergency evacuation only, thus requiring staff to walk all the way to the lobby from the south end of the laboratory building. This circulation problem has been remedied with the South stairwell now used for general movement, but does highlight the importance of circulation within the building, especially in light of the progression of samples, data and the like, from one area to another within the same research group.

A perceived problem that does exist is that the stairways and door heights (ill.5.10) are not conducive to the movement of large laboratory equipment. In the absence of a freight lift, bulky laboratory equipment needs to be hoisted with the use of a hired crane to one of the decks of the laboratory building. The railings of the deck need to be removed and often the sliding doors are not high enough, so sensitive equipment needs to be turned on its side to fit in. This situation was put to Derek van Heerden, an architect involved in the project. His response was that the design of the building was such that the movement of large equipment was purposely intended to be hoisted by forklifts, easily hired from the harbour close by, onto the balconies. Their handrails have been specifically designed to be demountable for this purpose (ill. 5.11). In relation to the inadequate door heights, he also mentioned that it was determined in the design stages that equipment to be used in the facility would be able to be accommodated by a standard 2100mm door. This situation demonstrates the need for a facility to be designed to accommodate the movement of large equipment, and allowances made for equipment larger than initially anticipated. Constant development in research technologies results in new equipment with the potential to be larger than standard, and a facility should be able to accommodate equipment of varying sizes.



*Illustration 5.10: These standard sized double doors, like many other doors in the Institute, do not facilitate the movement of large equipment well. The door should have been full height instead of having fanlights.*



*Illustration 5.11: The railings on the balconies are purposefully designed to be easily demountable to facilitate the hoisting of bulky equipment via forklift or crane.*

### 5.2.4 Structural system

The structural system used in the building is a concrete frame with a coffered floor slab and brick infill. The particular system was chosen as a balance between cost and achieving a suitable span. This did result in a row of columns in the centre of the space designed for laboratories, which constrains the laboratory layouts to contend with a fixed object in the centre of a space, and can result in planning difficulties. There was also a need for a separation within the structure to prevent vibrations generated from plant equipment housed therein to be conducted through the structure and to interfere with the laboratories. This was achieved by means of a structural joint between the 'service section' to the north and the laboratories.

### 5.2.5 Servicing

When the architects started with technical documentation, the first thing that they did was to determine the exact extent of the servicing required and designed to accommodate for it. During the course of construction, the servicing requirements grew, and additional service spaces were added on the parking level, such as gas storage (ill. 5.12) and a plant room. If the building had not been raised on pilotis, the tight site constraints would have resulted in the difficult accommodation of the additional services.

The approach to the services layout was to have designated zones assigned to each type within the allocated spaces instead of having a common zone for all. For example, gas services runs would be restricted to a predetermined zone in the ceiling void. This was to maintain clarity of servicing, making it easier to maintain and change over the lifespan of the building as well as preventing complications during construction. (Barrow: 2007) The ceiling plenum was divided into 4 vertical sections and the vertical ducts were assigned particular services. As the servicing requirement grew, the allocated spaces in which they ran were at times insufficient; therefore some services were attached to the exterior of the building. (ill. 5.13) This demonstrates that service spaces should always be designed with spare capacity.



*Illustration 5.12: The servicing requirements grew during construction, like many other research institutes, and servicing spaces became inadequate. Some additional service spaces, such as this gas storage area, were placed in the parking area.*



*Illustration 5.13: Some additional services attached to the exterior of the building due to the increased requirements during construction.*

Decentralised services, or the existence of redundancy systems are at some junctions critical to the building function, as relying on one centralised system could be catastrophic when it fails. An example is the specimen storage area. The building is serviced by the centralised air-conditioning, but it also has two independent ceiling units connected to the uninterrupted power supply, which is in turn backed up by generators. (ill. 5.14) The other need for decentralised systems is that different spaces within the building require different environmental conditions to be maintained, such as the laboratory spaces in general need to be maintained at a lower temperature to the office environment.

In servicing, it is also important to take cognisance of the need for waste generated within the building to be removed. Solid waste is removed and stored on site to be collected for disposal off site by a contracted firm. Waste gasses and air generated within the laboratory environment needs to be handled before being expelled into the atmosphere and generally passes through a HEPA filter. (Kisbey-Green: 2007) Sterilization of equipment, mainly glassware is done by means of an autoclave machine, and this needs to be accommodated with the design.

### 5.2.6 Environmental impact reduction

When it comes to strategies to reduce the building's environmental impact, the most notable one is the large movable vertical screens that feature prominently on the laboratory building. This solar control strategy in front of windows can be manually adjusted by the users and reduces heat build-up and glare predominantly from the harsh west light. As the decks also face west, there are screens (ill.5.15) that are also manually operated to deal with the harsh light. The building has a large roof overhang on the east façade that also shades the building, but due to the orientation and size of the overhang, this is probably only effective in the late morning when the sun has reached a higher altitude. With the building raised on pilotis, air can move underneath the building and can cool the structure down more effectively. (Cahi: 2007)



*Illustration 5.14 Uninterrupted servicing is crucial in certain spaces. Redundancy systems may be installed such as an independent ceiling mounted A/C in addition to the room being serviced by the centralised system, as shown above.*



*Illustration 5.15: Horizontal screens on the laboratory decks shade the space from the harsh west light.*

### 5.2.7 Finishes

The finishes in the building were particularly chosen to be resistant to spills and staining. Most notably was the Vinyl sheeting floor finish, which is also predominantly used in most other medical facilities such as hospitals and clinics. The joints were welded together in order to make a seamless covering. The vinyl sheeting was also taken up onto the wall as a kind of splash-back in an attempt to deal with the floor to wall joint. (ill. 5.16)

### 5.2.8 Other noteworthy aspects

Besides those listed above, there are other minor aspects from the user feedback that are noteworthy. The lack of storage in both the laboratory and office components is one aspect, there are boxes that line passageways and are stacked in offices. (Ill 5.17) In conjunction with this, there is also no real mechanism that deals with the initial delivery process of goods and supplies to the building. Air-conditioning within the building is a major issue, with airflow and temperature within each space sometimes causing user discomfort. (ill 5.18) This can mainly be attributed to a centralised system, as this does not allow for individual modification. A centralised system also allows for smells to be transmitted throughout the building. The offices should have a space for visiting staff to access the internet to check e-mail – in essence a small internet café. Natural light within spaces was also highlighted as important, as it can instil a sense of wellbeing. This can be clearly demonstrated by contrasting the administration space with greater amounts of light as compared to the clinical trials space with significantly less light. The laboratory spaces are somewhat isolated, and the design should take into account the need for laboratory staff to hear evacuation sirens. Some laboratory environments are noisy and deep within a structure, so sirens placed within the passageways are ineffective.



Illustration 5.16: Vinyl sheeting flooring with contrasting coloured skirt. Joints between sheets are torched to create a seamless floor finish.



Illustration 5.17: There is a lack of storage areas and a dedicated space to deal with deliveries, therefore boxes are temporarily stored in passageways.



Illustration 5.18: Due to the centralised nature of the A/C system, individual users do not have much control of their environment. Here, the fixed outlet directs air inappropriately and the staff of this office have erected a makeshift deflector.

### 5.2.9 Conclusions

Research institutes are increasingly cognisant of the benefits that inter- and multi- disciplinary interaction has in research environments. This interaction is facilitated by both formal and informal interaction. These types of interaction are facilitated in formal spaces, such as a cafeteria or conference room, and in informal spaces, such as stair landings, balconies and break-away spaces. In addition to facilitating interaction, break-away spaces can also reduce the overall size of accommodation required if appropriately designed. To achieve a usable compact space, designers have to be conscious of layout, use and placement of fittings and doors.

Though functional by nature, the building has the opportunity to have a unique character developed by the creative treatment of the architectural 'significant insignificants'. Elements such as staircases, decks and lobbies present the opportunity for creativity to be expressed. (ill. 5.19 & 5.20)

The design must facilitate the process of circulation. Movement of staff, samples and equipment needs to be taken into account, and openings should be appropriately sized to allow for this.

Aspects to note in relation to servicing requirements are:

- The need for allocation of spare capacity;
- the recommendation of assigning specific zones;
- implementing a flexible system that responds to the lifespan of the building; and
- the need for strategies to adequately deal with wastes produced. (ill 5.21)

Environmental impact reduction strategies employed are simple, and mainly concentrate on reducing energy consumption through appropriate shading. Of concern is that all spaces within the building are air-conditioned all year round. Though this is a requirement in the laboratories, it is not in other support spaces.



Illustration 5.19: The curved skylight structure over entrance lobby. In a building that has specific practical requirement, creativity can be injected into an ordinary building with elements such as these.



Illustration 5.20: Balustrade detail in main lobby. By being creative in areas where it is most feasible, it is possible to offset the potential regimented functional spaces.



Illustration 5.21: Hoist for transporting biological waste from the upper floors of the laboratory building to the temporary storage facility on the ground floor

### 5.3 Council for Scientific and Industrial Research, Durban

#### Campus

Laboratory wing:

Architect: Paul H. Connell

Date: 1958 -1959

Administration wing:

Architects: Leslie T. Croft / McLaren Alcock Bedford

Date: 1970

Location: 359 King George V Ave, Durban.

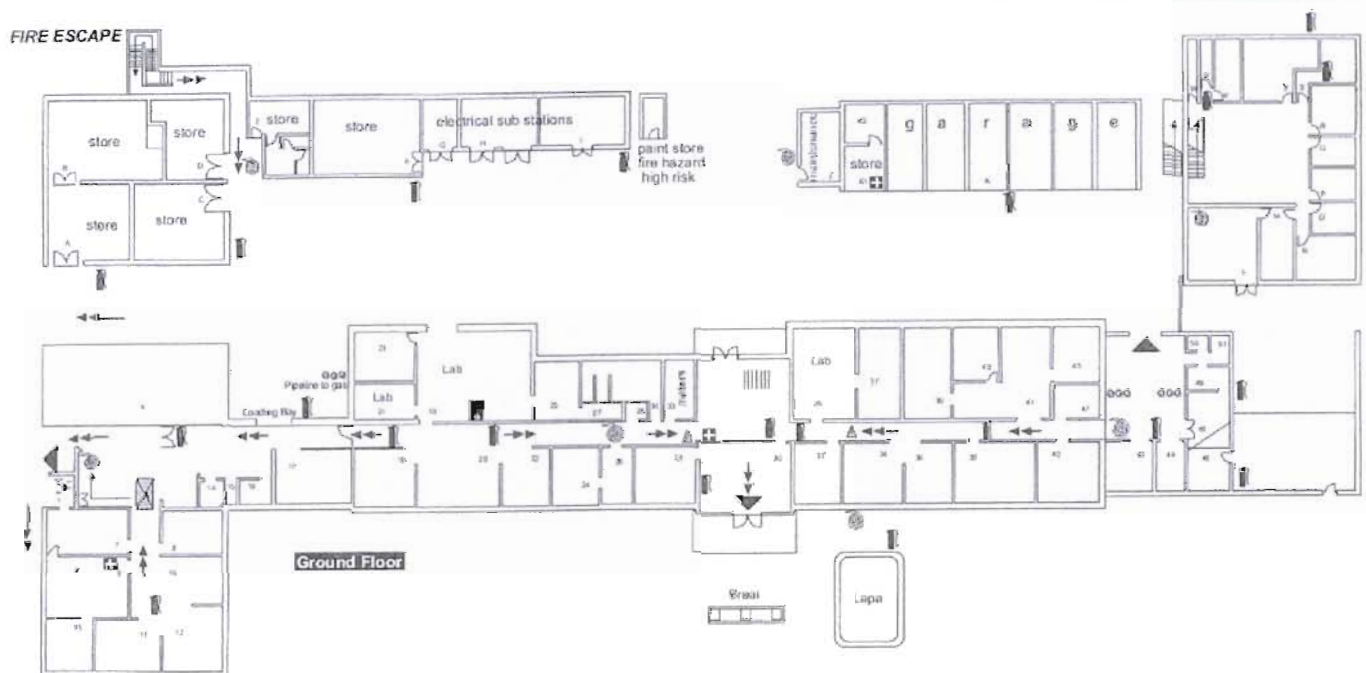


Illustration 5.23: Overall ground floor plan of the CSIR Durban Campus buildings. The laboratories and offices are on two levels and off of a double-loaded corridor.

Source: CSIR

#### 5.3.1 Background

Though this is a Natural Resources and Environmental research facility, it is useful in demonstrating the process of research within a given environment. It is also an independent research institute as opposed to a laboratory which is hosted by a department; therefore it is appropriate in the examination of an institutional environment. Of great interest is that the interviews also exposed the human dynamics within a research environment and demonstrated the ideological differences between researchers and management.



On the practical side, the CSIR Durban campus highlights many potential flaws in the design of a research institute. As the building was not initially designed to cater for the amount of services currently required, piping and outlets are run all over wall and ceiling surfaces in an ad hoc manner. (ill. 5.24) As pointed out by Steven Weerts, a project manager at the CSIR, once a pipe runs along a wall, you lose a surface that has potential to service another need, such as having shelving for storage. Wall mounted geysers that have had to be added to service the laboratories are 'space hoggers'. This demonstrates the need for dedicated service spaces of adequate size, an idea strongly supported by Weerts. The computer infrastructure added to the servicing problems with cables and trunking having to be run, and it is admitted that the campus should have gone wireless.

### 5.3.2 Research process and general planning

The process followed in the building is that samples are gathered off site and delivered to be 'stripped' – that being raw sample matter being extracted from the material brought in. This 'stripped' sample is then transferred upstairs to the laboratories (ill. 5.25) for further processed, and sometimes a small refined sample is transferred to a specialised laboratory for specific analysis using particular and sensitive equipment. (ill.5.26) Within the laboratory process, there is a distinctive separation between the 'wet' laboratory which deals with the raw sample and the 'dry' laboratory which contains the sensitive equipment. This protects the equipment from possible damage and protects the area from contamination. The results from laboratory tests are then e-mailed to the office of the researcher concerned. The building design does not lend itself to this process well, as samples have to travel between floors instead of the laboratories all being located on the ground floor and researchers offices being located upstairs.

Besides this inappropriate vertical placement of functions, the horizontal planning has some merit to it. The research building is accessed along a central spine that links it to the administration block. The layout on the lower floor has the service spaces, such as ablutions and sample receiving area



*Illustration 5.24: Trunking along a laboratory wall. As initial allocation for services were inadequate, new trunking is run in an ad-hoc manner and consumes otherwise usable wall*



*Illustration 5.25: A typical wet laboratory at the facility, where raw samples are processed.*



*Illustration 5.26: An example of a sensitive and sophisticated automated analysing piece of equipment. Samples are generally transferred from a wet to a dry laboratory that contains equipment like this.*

to the west side of the corridor and the researchers' offices with the better view to the east.

### 5.3.3 Laboratory requirements

The laboratory requirements at the Durban campus are similar to medical laboratories, and have to conform to similar legislation. The laboratories require strict access control. It was explained that this has little to do with any idea that the research was 'secretive', but was a requirement of accreditation to ensure quality in the findings as the risk of interference and contamination is reduced significantly. The strict access control also serves to keep uninformed individuals away from a potentially hazardous environment. (Weerts: 2007)

Within the laboratory environment, most of the reagents used are toxic and carcinogenic; therefore it is critical that fumes are extracted. This is mainly done by means of restricting these processes to fume cupboards. (ill. 5.27) If other extraction of air from the laboratories was implemented, it was suggested that it be at the level at which fumes were generated, avoiding researchers being exposed to rising fumes. (Weerts: 2007, Seitter: 2007, Griffin: 2000, 92) Though the laboratories only had emergency eye wash facilities (a legislated requirement) (ill. 5.28), it was suggested that having emergency showers, such as at DDMRI, in addition to eye wash facilities was preferred. (Weerts: 2007) In addition to this, Personal Protection Equipment (PPE) needed to be in a separate area, such as a locker area, so as to avoid contamination in the laboratory environment. (ill. 5.29)

### 5.3.4 Storage

Though not restricted to the laboratories, appropriate storage is crucial. Within the laboratory, there needs to be storage for glassware, equipment and reagents. As most reagents and samples are sensitive to ultra-violet light, it is ideal if all storage is away from direct sunlight, and cupboard space is preferred to open shelves. Usually the laboratory staff use any open surface as storage, most notably the window sills. (ill. 5.30) (Weerts: 2007) Obviously this restricts the opening of windows



Illustration 5.27: All hazardous processes within a laboratory, especially those generating fumes should be confined to fume cupboards such as the one in the background.



Illustration 5.28: Emergency eyewash facilities are essential in any laboratory environment.



Illustration 5.29: Personal Protection equipment should ideally be stored outside of the laboratory environment to reduce the chance of contamination thereof, and not in the laboratory environment, as shown here next to the emergency eye wash.

that are directly above the sill, and so placement of windows needs to accommodate this. Flammable substances need to be stored separately in designated areas. (ill. 5.31) There also needs to be an appropriately sized fireproof storage for files and data.

### 5.3.5 Ownership of space

Of particular interest in the research of this case study is how organisational structure has a direct impact on the built environment, and vice versa. Within the ranks of the staff there is a clearly defined hierarchy. Access to equipment and use of space is linked to seniority. (Van Heerden: 2007, Weerts: 2007) More senior staff 'require' more space and equipment for their exclusive use. Offices become their own self-contained environment with a small individual library, equipment storage, write up and examination spaces. This individual 'ownership' leads to the loss of an opportunity to rationalise space and resources as duplication occurs and resources then often stand idle. One is not sure if the individual office planning of the building has reinforced this ideology, or if it is the nature of researchers in general to covet their own space.

The concept of open plan office space was raised as an alternative. From the management side, this option seemed quite favourable. It was recognised that researchers can spend half a day at a workbench and if the layout was open-plan, the benefits would be that there was more opportunity to interact with other staff and therefore potentially be more creative in research. It would cut resources significantly while still being sufficient. There were concerns that the staff, entrenched in their hierarchy and ownership mentality, would be quite resistant to a conversion. (Weerts: 2007)

In contrast to this individual ownership are the areas where there is no real sense of ownership. This is most notable with the garages on site that have been taken over to serve as general storage. Here, equipment is stored carelessly and in a haphazard manner and junk accumulates. (ill. 5.32) This is an extreme example and probably results from staff not actually having to spend much time there at all. As there is no



Illustration 5.30: Laboratory staff tend to use all available open and flat surfaces for storage, such as window sills. This can constitute a hazard, as they have to reach over their workspace and could knock something over.



Illustration 5.31: Flammable materials and reagents in a laboratory environment need have specific storage needs. Specific technical requirements are mentioned in Chapter 7.



Illustration 5.32: Storage areas can become messy if no one has a sense of ownership over it. Admittedly, on a follow up visit to the campus, many of the garages had been tidied out.

'ownership' due to no one being directly responsible for them, there is also no regard given to use of the space as there is no apparent accountability in the use of the space.

### 5.3.6 General aspects

Other noteworthy finding to come from the study related to finishes, informal meeting places and minor servicing requirements. In many of the areas in the laboratories, surfaces were stained and scuffed as they were not impervious to chemical spills. (ill. 5.33) In addition to being unsightly, it gave the appearance of the environment being unclean, though this is hardly the case. The unsuitable choice of flooring has resulted in some tiles being damaged and delaminating from the screed, most likely due to the vinyl tiles joints allowing liquid through or poor adhesive being used. (ill. 5.34)



Illustration 5.33: Laboratory chemical spills have a tendency to stain standard worktop surfaces, as seen above, therefore special surfacing is required.

A need for informal discussion spaces was also highlighted. Even though the space is not conducive to discussions, the morning staff meetings were often held in the passageway in front of the assignments board. This was deemed more favourable than having to congregate in a conference room. The formality of having to call a meeting at a particular separate venue seemed to be an inconvenience in comparison to meeting informally within the immediate environment of the concerned staff. (Weerts: 2007) Lastly, the need for sufficient electrical sockets was emphasized. The lack of service spaces in the design has resulted in copious amounts of unsightly and haphazard trunking being added after the laboratories were initially occupied. Also, due to the increasing mechanisation of the research environment, the need for electrical sockets has increases over time and will most likely continue to do so.



Illustration 5.34: Floor and worktop surfaces need to be particularly durable in a laboratory environment. Generally, vinyl sheet flooring is used with the joints torched, as standard vinyl tiles are inappropriate as spills can penetrate the joints

### 5.3.7 Conclusions

The building had insufficient allocation of service spaces which resulted in subsequent requirements being added in an ad hoc fashion. This demonstrates:

- The need for a flexible service approach;
- The need for the inclusion of spare capacity; and
- Selecting service options that have less service requirements (such as using a wireless LAN network)

The implementation of open plan offices would result in:

- A greater synergy between staff; and
- A reduction in resource requirements as greater sharing would be feasible.

Planning aspects should include:

- A facilitation of the research process in both vertical and horizontal circulation.
- The accommodation of informal meeting places at appropriate places facilitate informal processes that naturally occur in a research environment.
- Appropriate storage of flammable substances and files.
- Stringent access-control to sensitive areas.
- The inclusion of locker areas for laboratory staff.
- Dedicated storage space for personal protection equipment.

Other recommendations resulting from the study include:

- Fume generating processes be restricted to fume cabinets; and
- Other processes generating exhaust heat or gasses should be extracted at the level they are generated. (ill 5.35)



*Illustration 5.35: This particular piece of equipment generates exhaust air that is hot. An extraction hood has been installed to exhaust the air to the outside of the building. Similar hoods can be used at individual workspaces. Generally the hood should be wider than the outlet.*

## 5.4 Block H Physics and Chemistry Laboratories

Architects: Seitter Boyd Architects

Location: University of KwaZulu-Natal, Westville Campus

Date: 2007

### 5.4.1 Background

Though not directly related to medical research, the inclusion of the Block H Laboratories offered a unique opportunity in that the laboratories were in the process of being refurbished at the time of conducting the research for this case study and demonstrate the trend in general laboratory design of the time. The building itself is an assortment of undergraduate and postgraduate laboratories along with administration offices for the chemistry and physics departments of the university campus. The facilities are primarily used for instruction and not for research; therefore certain aspects are informative, but not directly relevant. Of particular interest is the approach taken to servicing and planning in the laboratories by the architect, Gerald Seitter of the local firm Seitter Boyd Architects, which is in line with international trends of the time.

What is to be remembered in a research institute design is that the laboratory is the environment where ideas are tested and not primarily conceived. Ideas are generally the result of informal discussions with colleagues over a cup of coffee or taking a break, and these usually take place outside of the laboratory environment. (Seitter: 2007) The original building does not accommodate the idea of break-away spaces well, but in the retrofit, the architects have tried to introduce this concept with seating in corridors (ill. 5.36) where possible and other external spaces. These break-away spaces are in close proximity to the laboratory environments, and this has been shown in the precedent studies to be part of the success of such spaces. (Treib: 2006, 413)



*Illustration 5.36: In recognition of the social aspect that should be encouraged within the overall laboratory environment, the architect of the refurbishment has included seating areas where appropriate to facilitate informal conversations.*

#### 5.4.2 General planning

Within the laboratory space, an effort has been made to minimise the amount of serviced space and maximise the amount of write-up space. This rationalization of space leads to a more economical and a somewhat safer environment. The minimisation of service runs reduces overall costs slightly, but the benefit is more so in creating a safer environment. This focus on safety seems to be a major focus of modern laboratory design. The actual laboratory spaces are the most hazardous; as this is where reagents and potentially toxic material is used, created or exhausted. By reducing the size of the hazardous area, greater control is gained by means of improved oversight, and by implication, a safer laboratory environment is created. The nature of the research environment has also changed. Before, researchers sometimes worked with chemicals that produced noxious gasses at their individual work bench. A growing trend nowadays is to restrict 'the nasty stuff' (the potentially dangerous and also messy parts of the research) to areas such as fume cupboards. (Seitter: 2007, Griffin: 2000, 50) This restriction leads to a safer and cleaner working laboratory environment in general.

Glass partitions are also used extensively in the laboratory environment. (ill. 5.37) This adds to the safety of the environment as surveillance of the general environment is enhanced and researchers stepping away from their workbenches momentarily can keep an eye on ongoing experiments. This also adds to the communication within the environment, though mostly non-verbal communication, and this in turn adds to teamwork being more efficient. (Seitter: 2007, Griffin: 2000, 107) Linked to the use of glazing is the admission of some reflective natural light into spaces that do not have outside facing windows.

#### 5.4.3 Laboratory module

Tied in with the rationalization of space is the emphasis on modular fittings and standardised spacing. Though there is no industry standard laid down in South Africa, the international norm is to have a minimum of 1450mm of space between work benches in the laboratory. This allows for 450mm for sitting at



*Illustration 5.37: With the inclusion of glass partitions within the laboratory environment, spaces become safer, more conducive to communication and more social.*

the bench on both sides and 550mm for circulation. (Seitter: 2007) This spacing also facilitates the movement of bulky equipment within the laboratories, which is an important component when planning as the DDMRI case study proved. The use of an accepted module size also allows for ease of retrofitting of laboratory spaces and the interchange ability of equipment and fittings on a broad scale. In further research, the actual module size recommended as an Industry standard is 1500mm by 1500mm (Griffin: 2000, 21)

#### 5.4.4 Servicing

The servicing within the building was most informative, as it demonstrated the latest trends. The building was originally designed with an abundance of vertical service shafts, (ill. 5.38) but this trend has fallen into disfavour, mainly because it creates a flue for the rapid spread of fires between floors. (Seitter: 2007) The approach followed in the Block H retrofit is to have services running along the main passageway of each floor. (ill. 5.39) The services are supported on a 'ladder' system and are exposed. All servicing within the laboratory, save for gravity-dependent servicing such as plumbing, is from the top. Perpendicular service runs then tap into the main pipes in the passageway where and when needed. When a service is in use at the workbench, one merely 'plugs into' it from above. Due to the increasing emphasis of safety in the laboratory environment, all services are exposed to allow for the free movement of air within a space to allow for hazardous gasses released within the environment to be easily extracted. By housing services within a dedicated, contained space such as a ceiling void, the opportunities arises for dangerous and toxic gases, that are in this instance less dense than air, to be trapped in the space and this constitutes a risk. (Seitter: 2007) This planning for free movement of air is also carried through to the laboratory fittings with laboratory workbenches being raised off the ground on legs for air at floor level to circulate and for easy cleaning of the floor. (ill.5.40)



Illustration 5.38: Each group of vertical green pipes indicate a vertical service shaft. This was a popular servicing approach in the past, but has fallen out of favour due to the fire risk it poses.



Illustration 5.39: Primary service runs are fixed to a ladder suspended from the passage ceiling. Connections then branch off to work benches from above where required.



Illustration 5.40: Laboratory fittings are elevated on legs to allow for unrestricted movement of air to minimise the potential build up of dangerous gasses.

Services within the building are also standardised as much as possible to allow for ease of maintenance and to keep installation and maintenance costs down. Systems, such as air-

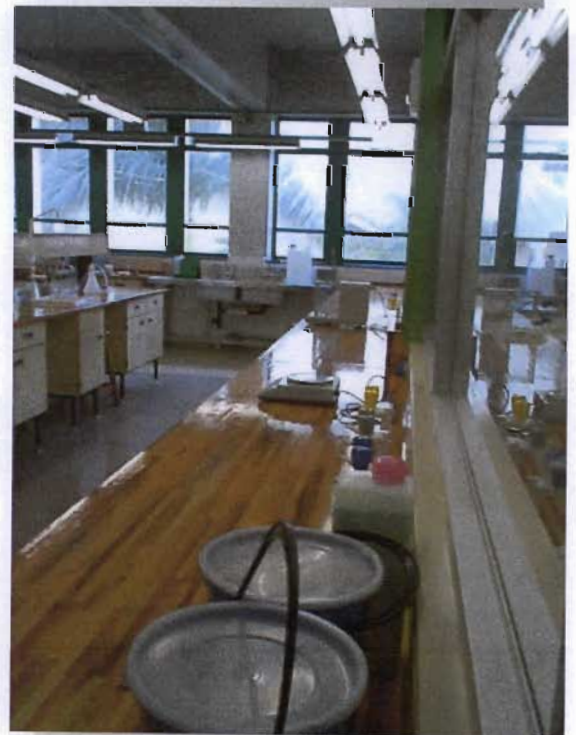


conditioning units, are kept as standard as possible and allows for much of the maintenance work to be done in-house by full time staff of the Physics and Chemistry schools that occupy the building. Should there be specialised equipment, specifically skilled technicians from an external firm would be required to maintain it. The theoretical benefits of having in-house staff being able to maintain the facilities is that it is more affordable than contracting out with an external firm in the long run and results in repairs being effected more speedily. (Seitter: 2007) Whether this will indeed be the case in the long term is yet to be determined.

Where economically viable, services have been kept as decentralised as possible. An example of this is the air-conditioning system. It works on a central water chiller supplying separate air handling units in the individual spaces to be air-conditioned. This allows for individual spaces to have specific and differentiated environmental conditions, but in spaces occupied by many people, a "service balance" still needs to be achieved where a middle ground is catered for. (Seitter: 2007) This system is more suitable than a central one, but it is still dependent on a single water chiller, which is not ideal. If the single water chiller is non-functional, the entire building is without air-conditioning. What the architect also highlighted is that users often artificially cool the laboratories to below 20°C. When a space needs to be exhausted, large quantities of untreated, humid, natural air is pumped in causing large amounts of condensation to form on the cold surfaces, thus resulting in what he termed 'the rain-forest effect'. This demonstrates that the humid conditions of Durban need to be taken into account in regards to ventilation, and could possibly be resolved by a dehumidification system being employed.

#### 5.4.5 Work surfaces

The final thing to be highlighted about the laboratories is the worktops. Here, saligna timber pieces have been laminated and coated with polyurethane. (ill. 5.41) The use of timber, especially a coated laminate, seemed to be in contrast to other previous findings in regards to work surfaces, as synthetic



*Illustration 5.41: Though inappropriate for a medical laboratory, the use of laminated saligna timber worktops is practical in this instance.*

and impervious material is highly recommended. The architect confirmed that this surface would be unsuitable for any laboratory dealing with medical research and that it was specifically used here to facilitate the overall environment servicing the work that is conducted therein. The timber worktops allowed for equipment to be temporarily screwed to the work surface, or for the surface to be sanded down and re-sealed should they be stained or damaged. This shows that the overall environment should facilitate the function that takes place within it in concept and in detail.

#### 5.4.6 Conclusions

Though the Westville Campus Block H laboratories are for physics and chemistry, and therefore differ substantially in the nature of work done in the laboratory environment, their study is illuminating in that it highlights current international laboratory design trends in terms of physical planning, the research process undertaken and servicing.

Social spaces are seen as integral to the overall design and informal interaction is facilitated by the inclusion of break-away spaces (ill 5.42) and glazed partitions. Another planning recommendation is the use of a 1.5m module will allow for interchange ability and ease of retrofitting.

Safety in the design is incorporated by:

- Minimising the size of serviced spaces;
- Increasing observation with the inclusion of more glazing partitions; and
- Restricting hazardous processes to fume cupboards

Servicing recommendations to come from the study are:

- Servicing should be from above;
- Main service lines should run horizontally on a ladder;
- Vertical service shafts should be kept to a minimum;
- There should be easy connects/disconnects into the bulkhead above the workbench (5.43); and
- Standardised service components should be used where possible.



Illustration 5.42: Outdoor seating facilitates the social aspect of laboratory work.



Illustration 5.43: Laboratory benches are serviced from above. The supply branch connects to the primary supply runs that run along the passageway.

## 5.5 Overall conclusions drawn from case studies

### 5.5.1 General remarks

Many of the conclusions drawn from the case studies reinforce findings from the precedent studies; therefore to avoid repetition, only particularly relevant conclusions not previously mentioned will be made. It is therefore advisable to read the sections of overall conclusions of the precedent and case studies in conjunction with each other.

### 5.5.2 Site

The building should be orientated correctly if possible to minimise solar gain and glare. Correct orientation needs to be balanced with response to topography and exploiting views.

### 5.5.3 Servicing

Recommendations concerning servicing are as follows:

- A drop-down system from bulkheads above benches with easy connects/disconnects should be used.
- Main service lines should run horizontally with supply lines tapping into them perpendicularly.
- Spare capacity in service plants, spaces, supply and runs is required.
- Decentralisation should be implemented where possible.
- Service lines should be exposed to allow for ventilation of any potential build-up of gasses.
- Specific service ducts and zones should be assigned.

Other service requirements are:

- Uninterrupted power supply (UPS) with backup generator for dedicated circuits.
- An external gas storage area.
- Specific mechanisms to dispose of solid, liquid and gas wastes generated in the laboratory.

### 5.5.4 Flexibility

Flexibility is a key component to the lifespan of the building and is linked with the particular service approach, and appropriate module size and planning.

### 5.5.5 Planning

The recent trend in laboratory planning towards providing a safer environment is assisted by:

- Increasing observation by incorporating glazed partitioning;
- Reducing the size of a potentially hazardous environment; and
- Restricting hazardous processes to designated areas, such as fume cupboards.

Aspects to consider in general planning include:

- Placement and design of break-away spaces, especially in a compact design;
- Careful placement of openings for maximum usability of spaces;
- Implementing open-plan offices with a cellular component included where audio and visual privacy is required;
- The appropriate design response to horizontal and vertical circulation of staff and goods; and
- The provision for deliveries being made and bulk goods being stored.

### 5.5.6 Physical environmental requirements

In addition to certain planning requirements, provision needs to be made for the following in laboratories:

- Strict access-control to sensitive areas.
- Eyewashes and emergency showers.
- Separate storage for personal protection equipment and effects of laboratory staff.
- Separate and specifically designed storage for flammable substances.
- Provision for the exclusion of direct natural sunlight as sensitive equipment and substances are negatively affected.
- Finishes should be non-porous, and be resilient to spills and abrasion through normal use.

### 5.5.7 Environmental impact

In light of the great environmental impact the building has, reduction thereof is important. Strategies to consider emanating from the case studies include:

- Reducing energy consumption through appropriate shading and limiting the use of air-conditioning;
- Incorporating natural light where feasible; and
- Orienting the building correctly.

### 5.5.8 Social component

Increasingly, the benefits to research outputs from inter- and multi- disciplinary interaction is being realised. Aspects that foster this include:

- Break-away and other more formal social spaces (such as a cafeteria);
- Elements that facilitate lingering, such as passages that wide in sections and wider stair landings; and
- Glazed partitions that allow for non-verbal communication.

### 5.5.9 Imagery

The highly specialised and practical requirements of a laboratory building has the tendency to direct the design response in a rational, yet architecturally staid response, this can be mitigated by:

- Creative expression of elements such as lobbies, staircases and balconies;
- Exposing building users to laboratory views of the 'exciting stuff', such as auto analysing machines in operation etc, which is traditionally hidden away; and
- Utilizing piping and other service elements as a design component.

---

## **Chapter 6 – Formulation of the design brief**

### **6.1 Introduction**

From the precedent and case studies, interviews and literature review, certain findings have been derived. In this chapter, the findings from each source inform the answers to key question with the data collected being synthesised.

The chapter will be structured into two major sections, namely:

- Brief derivation
- The brief

The outcome of the chapter is to establish firm guidelines to enable the best design and siting of a New Cancer Research Institute for Durban. Specific technical and environmental criteria will be discussed separately in Chapter 7.

### **6.2 Brief derivation**

This section deals primarily with contextual information towards the formulation of the actual brief a client would issue the architect.

#### **6.2.1 Client**

The National Health Laboratory Services of South Africa (NHLS) is a government institution involved in research, diagnostic laboratory services, teaching and training amongst other activities across South Africa. The NHLS Act of 2000 saw the amalgamation of the South African Institute for Medical Research, the National Institute for Virology and the National Centre for Occupational Health to form the NHLS. The client has established relationships with the Department of Health, the Cancer Association of South Africa, the South African Medical Research Council, pharmaceutical companies, and a number of overseas institutions, among others (National Health Laboratory Service: 2007). For the purposes of this project, the NHLS will be the primary client.

### 6.2.2 Client's objectives

As a major role-player in the public health care sector, the NHLS has the following objectives:

- To provide a world-class health laboratory service through competent, qualified professionals and state-of-the-art technology, supported by academic and internationally recognised research, training and product development.
- To conduct research appropriate to the needs of the broader population, which include cancer research.
- To make major contributions to national and international medicine

In light of the Client's objectives, the cancer research institute is to conform to international standards in planning and servicing and create a pleasant environment that attracts and retains a high calibre of staff to conduct the research and facilitates the research process.

### 6.2.3 Funding

The client, the NHLS, has pre-existing funding relationships with the Cancer Association of South Africa (CANSA). CANSA has in the past secured funding for research projects conducted by the NHLS. In this scenario, CANSA has secured research grants to cover the cost of construction of the new Cancer Research Institute. The NHLS generates funding through their diagnosis service and this, in conjunction with research grants that they should receive, will provide the running capital for the Institute.

### 6.2.4 Function and users

As mentioned in Chapter 1, cancer research can be broken up into five main types, namely: basic research, translational research, clinical trials, behavioural and population research and psychosocial research. Basic research will be conducted in this facility, in line with one of the current functions of the client, the NHLS. Therefore the building users will be medical researchers and support staff and administration personnel. The staff component will comprise of 90 to 120 people. This building is not intended to be accessible to the general public, and does not cater for clinical trials. Allowances will be made

for visitors to the facility, but the number of incidental visitors is limited. Facilities are to be included to accommodate occasional conferences of up to 100 visiting professionals.

#### 6.2.5 Environmental requirements

Due to the high service requirements of the building, energy and water consumption is typically five times more per square metre than that of a typical office building (Watch: 2007, n.p.).

This is as a result of:

- The need for many containment and exhaust devices;
- Intensive use of heat generating equipment;
- Scientists requiring 24 hour access;
- Equipment requiring fail-safes; and
- Certain areas requiring intensive ventilation

The minimisation of the impact the building has on the environment is facilitated by focusing on improvements in efficiencies and productivity, a reduction of the needs of artificial environments and the built form facilitating energy efficiency. Particular strategies will be discussed in Chapter 7.

#### 6.2.6 Construction systems and materials

The general requirements of the constructional system are that the system allows for flexibility of the spaces created and also allows for easy expansion. These requirements suggest a modular frame and infill system being implemented. Constructional systems and materials should also respond to environmental sustainable design principles. Specific aspects in regards to structure will be discussed in Chapter 7.

#### 6.2.7 Site requirements

Due to the very specific nature and requirements of the building and its function, the following aspects affect site selection.

According to Watch (2007, n.p.), they are:

- Proximity to a research university;
- The availability of a highly educated workforce;
- Quality of life of the nearest city;
- Proximity to a major airport; and



- Ability to expand at the same site.

In addition to these aspects, Putnam Gould (1986, 50 - 51) lists:

- Access to utilities as the building is a heavy consumer of power and water, and has specific waste disposal requirements.
- Consideration of the surrounding environment as noise, dust and vibrations may be detrimental to the building functions.
- The immediate and surrounding environment should be pleasant (with views, landscaping etc.) to be a positive factor in recruitment of personnel.

### 6.2.8 Architectural form and massing

The site plan should be simple, orderly and regular and should allow for expansion. The visitor's entrance should be obvious and signposted to minimise visitors wandering around on site (Griffin: 2000, 27). In addition, Griffin (2000, 28) suggests that a single-storey laboratory component is optimum as multi-storey requires vertical ducts which increase the risk of the spread of fire [also confirmed by Seitter: 2007] and increases the building construction costs with added circulation. This obviously needs to be balanced with other design considerations.

### 6.2.9 Design objectives

The major design objectives are to create a pleasant environment for human habitation while still providing the functional requirements that facilitate research as well as providing for a 'social building'. "*Science functions best when it is supported by architecture that facilitates structures and informal interaction, flexible use of space, and sharing of resources*". (Watch: 2007, n.p.) The building also needs to be appropriately serviced.

## **6.3 The Brief**

### 6.3.1 Building functions

The principal aim of the brief is the creation of a research environment for basic cancer research. The functions to be catered for in the building are:

- 1) Laboratory spaces:  
Included in this are both open and closed laboratories and laboratories with particular requirements
- 2) Laboratory Support Spaces:  
Facilities such as storage, glassware wash up, and locker rooms are included.
- 3) Researcher offices  
Individual offices for senior researchers as well as functions that require privacy and open-plan offices for individuals involved in teamwork research are included. Amenities such as meeting rooms and break-away spaces will also be included
- 4) Administration offices  
General administration functions will be accommodated, separate from the laboratory environment. Included in this section is building support functions such as a central computer server room and general purpose conference rooms.
- 5) Social Amenities  
Apart from the incidental social spaces, specific social facilities also need to be included. These include a cafeteria, library and outdoor seating area.
- 6) Parking  
An appropriate amount of parking needs to be provided. Local Authority regulations require a ratio of bays to total area of the entire facility, but this results in a gross oversupply of parking needs for the amount of users indicated. *"If parking spaces must be computed on the basis of gross floor area per space for all occupancies, the number of spaces for a lab may be unduly high"* (Putnam Gould: 1986, 51). It is therefore appropriate to exclude mechanical spaces as these are unoccupied and laboratory spaces as there is a duplication of occupation with the research office space.

---

### 6.3.2 Accommodation schedule formulation

In the formulation of the brief, an analysis of areas of precedent and case studies was prepared, attached as Appendix B. From this analysis, an average ratio of spaces was determined. The client's needs were then used to determine an initial accommodation schedule. This was then compared and contrasted with the averages determined to adjust the area allocation to be more accurate. The accommodation schedule is attached as Appendix A.

---

## **Chapter 7 – Technical and Environmental Criteria**

### **7.1 Introduction**

Due to the highly specialised technical and environmental criteria of the facility and the implementation thereof, these criteria are being dealt with in this separate chapter. Particular aspects to be dealt with are as follows:

- Social facilitation
- General Planning
- Environmental impact reduction
- Servicing
- Safety
- Structure
- Illumination
- Finishes
- Storage
- General aspects

Many of the recommendations are drawn from international sources as a form of 'best practice guide'. It is advisable to comply with these international standards and recommendations, though it may not be mandatory. Specialist equipment and fittings can then be easily incorporated, irrespective of their origins and the general research environment is then globally uniform. (Griffin: 2000, 28)

### **7.2 Social facilitation**

As discussed previously, the trend in modern research facility design is to acknowledge the direct role that social interaction, both formal and more importantly informal, has on the research outcomes. This phenomenon is also linked with the nature of the modern research environment, which requires an environment that can adapt easily to changing technologies and research programmes while maximising the use of resources. The design needs to cater for these aspects. (Watch: 2007, n.p.)

Watch (2007, n.p.) further outlines the architectural response to the facilitation of social interaction with the inclusion and appropriate design of the following elements:

- Meeting places such as break rooms, discussions rooms, atria, central social spaces and stair landings.
- Research team spaces with the provision of facilities nearby to facilitate an efficient working environment.
- The minimisation of spaces identified with particular departments.
- The establishment of clearly defined circulation patterns. (ill 7.2)
- The use of interior glazing where appropriate to allow for individuals to see each other and engage in non-verbal communication.

### **7.3 General planning**

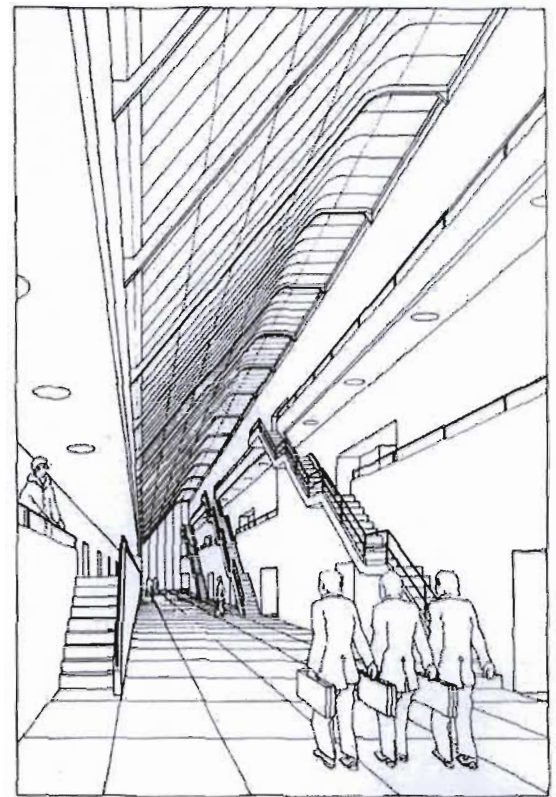
#### **7.3.1 Environment sympathetic to human habitation**

Spaces other than the laboratories should be well considered in terms of creating a total environment that is unified and is at a human scale. Some aspects to achieve this have been mentioned in 7.2 *Social Facilitation*. Other aspects suggested by Putnam Gould (1986, 65) include:

- Exploitation of views to any natural features.
- Creating outdoor amenities.
- Incorporating natural light.
- Allowing for individual preferences to be accommodated in the work environment.
- Providing adequate ancillary facilities such as a library, cafeteria and lounges. (ill. 7.3)

#### **7.3.2 Massing**

A single storey facility is optimal. This creates an environment which facilitates both the re-arrangement of departments, and the process of movement of samples and individuals throughout the facility, and this arrangement is configuration is convenient for the staff. It is usually well suited to flat sites, but it also results in a large footprint. By designing over multiple storeys, one increases the density of habitation - thus encouraging informal interaction - decreases travelling



*Illustration 7.2: A sketch of the clearly defined circulation route in the Olivetti Headquarters, Milton Keynes, Buckinghamshire, UK. This was a generator for the Ernest Oppenheimer Life Sciences Complex, University of the Witwatersrand.*

*Source: (Cooke: 1984, 46)*



*Illustration 7.3: The Library, Patcenter, Princeton, with Richard Rogers Partnership as architects. Provision of ancillary spaces is important to create a humanized environment for staff.*

*Source: (Boles: 1985, 71)*

distance within the complex and reduces its footprint. Multiple storey building may however require vertical ducts – which presents a fire hazard, and adds to the construction costs in the form of stairs and lifts. (Griffin: 2000, 27)

As mentioned in Chapter 6, the visitor's entrances should be obvious and well signposted to reduce visitors being confused and wandering around on site. In addition, the site plan should be simple, orderly and regular. This type of planning will easily allow for extensions. (Griffin: 2000, 27)

### 7.3.3 Work spaces

There are unpredictable changes that occur in equipment design and requirements. In addition to this, individual research projects having limited lifespan. A flexible laboratory space is therefore required to accommodate potential changes. (Griffin: 2000, 58)

Unless there is a special requirement, functions should be combined into shared open spaces as this allows for spaces to be easily reallocated. (Griffin: 2000, 33) Offices and write-up areas should be designed to allow for team work. (Watch: 2002, n.p.) Staff can be territorial by nature (Griffin: 2000, 6); therefore if fully enclosed offices are required, these should be justified by a need for visual and aural privacy rather than to satisfy an individual's preference. (Putnam Gould: 1986, 62)

### 7.3.4 Types of laboratories

There are two basic planning approaches to laboratories, namely open and closed. These laboratories can either be classified as wet and dry. According to Watch (2002, n.p.), their particularities are as follows:

Open laboratories (ill 7.4):

- Allow for easy sharing of resources;
- Facilitate communication between laboratory users; and
- Are more easily adaptable.



*Illustration 7.4: A general view of an open plan laboratory. A growing trend in laboratory design is to design these where possible to facilitate social interaction and sharing of resources. Source: (Braybrooke: 1986, 109)*

Closed laboratories (ill 7.5):

- Generally geared towards an individual principal investigator;
- Specific research is usually conducted; and
- Contains specific equipment.



Illustration 7.5: A typical laboratory floor plan of the Doris Duke Medical Research Institute indicating the division to create closed laboratories.

Source: East Coast Architects

Wet laboratories (ill 7.6):

- Contain sinks, piped gas, and fume hoods generally;
- The countertops are chemically resistant;
- Are supplied with 100% outside air; and
- Contain some fixed casework.

Dry Laboratories (ill 7.7):

- Usually have significant electrical and data wiring;
- Are computer intensive;
- Reticulated air is acceptable; and
- Can be outfitted entirely of mobile casework.

**7.4 Environmental impact reduction**

7.4.1 General

By its very nature of exacting service requirements, this type of facility consumes five times more energy and water per square meter than a typical office building. (Watch: 2002, n.p.) The need for reducing the impact on the environment therefore becomes paramount. The main issue is to satisfy the requirements with the minimum energy demand and to use energy from low impact sources. (Griffin: 2000, 70)

Factors that Watch (2002, n.p.) highlights as contributing to the high consumption include:

- Extensive containment and exhaust requirements;
- Large amounts of heat generating equipment;
- Scientists requiring 24hour access;
- Equipment and processes requiring fail-safes; and
- Intensive ventilation requirements.

Watch (2002, n.p.) then argues that the focus should be on improving the efficiencies and productivity of these systems



Illustration 7.6: A typical wet laboratory with numerous piped services, sinks and continuous workbenches.

Source: (Griffin: 2000, Plate 16)



Illustration 7.7: A typical dry laboratory. Electronic equipment dominates the space. Mobile casework is most suitable for this environment as under counter cabinets and workbenches can be easily modified to suit changing requirements

Source: (Griffin: 2000, Plate 05)

and their use. Many opportunities exist to minimise demand through efficient servicing, particularly in a new development. Efficient servicing reduces operational costs and improves the comfort, productivity and general well being of the users. (Griffin: 2000, 70)

Energy conservation methods from the design aspect are mainly to do with orientation and the outer skin of the building, and should be a first principle approach in the design. (Griffin: 2000, 71)

*"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)

The strategies of an energy efficient envelope (ill 7.8) and service systems that minimise energy consumption are also echoed by Loring (1986, 75). Griffin (2000, 70) does however suggest that services, such as artificial lighting, mechanical ventilation and air conditioning, offer the biggest scope for savings. The architect's role also includes encouraging the other consultants on the project to follow energy conservation principles. (Griffin: 2000, 28)

Further issues for consideration to enable a more sustainable operation of the facility are suggested by Watch (2002, n.p.) include:

- Increased energy and water conservation and efficiency
- Reduction / elimination of harmful substances and waste
- Improvements to the interior and exterior environments which will in turn lead to increased productivity of the staff
- Efficient use of materials and resources

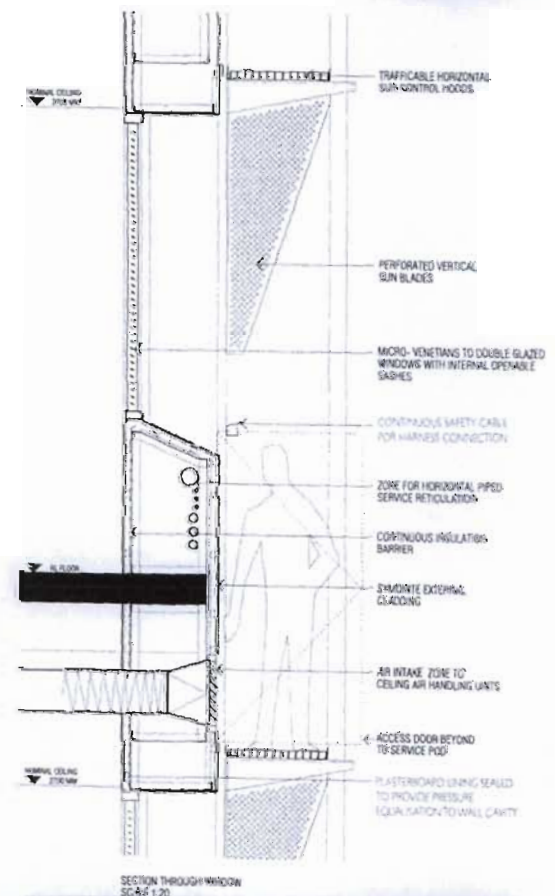


Illustration 7.8: Energy consumption within the building can be mitigated rather effectively with the appropriate design of the outer skin of a building. The illustration demonstrates horizontal and vertical solar shades, insulated walls and double glazed windows with internal operating horizontal blinds. Source: (Griffin: 2000, 209)



- Recycling of grey-water and energy through recovery systems

7.4.2 Particular strategies

7.4.2.1 General planning

Where possible, an environment should be designed that encourages sharing of equipment. Examples include open plan offices and laboratories. By sharing resources, equipment and material costs are reduced. (Watch: 2002, n.p.)

7.4.2.2 Walls and windows

Appropriate insulation of walls reduces heat exchange. Openable windows may increase energy usage in artificially controlled environments, but also enhances the quality thereof and may be preferred by the occupants. (Watch: 2000, n.p.) If spaces do not fundamentally require artificial control, natural ventilation should be investigated. (ill 7.9)

7.4.2.3 Roofing

Roofing should be light coloured and coated to reflect incoming solar radiation. The amount and type of roof insulation will depend on the climate. (Watch: 2002, n.p.)

7.4.2.4 Water

Pipes carrying hot or chilled water or steam should be insulated. Considerations should be given to a localised system for providing hot water for washing (40°C) as opposed to a centralised system. Ultra low flow taps and dual flush ultra low flush toilets should be installed. Rainwater and grey-water should be harvested and can be used to water the landscaping. (Watch: 2002, n.p.)

7.4.2.5 Lighting

Compact fluorescent light bulbs should be used instead of incandescent ones. A combination of task (ill 7.10) and ambient lighting (ill 7.11) should be employed to reduce overall high illumination levels. (Watch: 2000, n.p.) Where appropriate, natural day-lighting should be exploited, but energy savings will only be gained if the artificial lighting is appropriately switched. (Griffin: 2000, 74) By using high

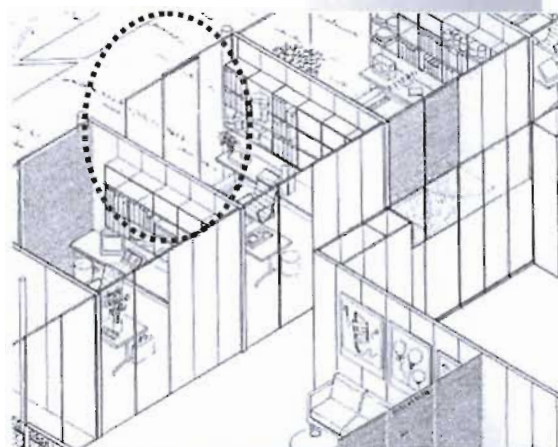


Illustration 7.9: The individual researcher offices at The Schlumberger Cambridge Research Institute has windows to allow for the use of natural ventilation (see circled area in illustration). Source: (Groák: 1985, 48)



Illustration 7.10: Task lighting is included on the underside of the service carrier to illuminate the directly affected work area. Source: (Waldner Firmengruppe: n.d., 34)



Illustration 7.11: Lighting included on top of the service carrier provides ambient lighting in the laboratory. Source: (Waldner Firmengruppe: n.d., 34)

efficiency luminaries with mirror louvers, electronic ballasts and automatic dimming with daylight sensors, an energy saving of up to 75% can be achieved. (Griffin: 2000, 34)

7.4.2.6 Ventilation

Many laboratory environments require 100% of the air to be exhausted and this adds an increased energy demand in relation to conventional air-conditioning operations. Specific techniques to reclaim energy include the use of rotary air-to-air heat exchangers, plate heat exchangers, run-around systems and single tube heat pipe. (ill 7.12) An appropriate system needs to be investigated in conjunction with the mechanical engineer. (Loring: 1986, 75). A good example of an energy efficient air-conditioning system is employed at the Pacific Power Research Laboratories, University Of Newcastle, New South Wales, Australia. Here, the system includes a computerised building management system, relief air system using economy cycles, multiple air handling units addressing specific and diverse needs, and night flushing ventilation. (Griffin: 2000, 125)

7.5 Servicing

7.5.1 General

The nature of the research environment is constantly changing and there is a trend towards increasing mechanisation. (ill 7.13)(Griffin: 2000, 45) The effect is that more electronic and automated instrumentation need to be accommodated in the laboratory environment. This in turn leads to greater power, data, and communication requirements. The focus in providing services is to seek a compromise that will satisfy most of the need of the current users and be able to easily adapt to suit future users and their research programs. (Griffin: 2000, 3).

These two aspects of changing technology and changing research programmes demonstrate the need for laboratory spaces to be flexible. (Griffin: 2000, 85) The service installation and design will be performed by engineering consultants and the manufacturers supplying equipment, but the architect must be involved in the process as the building design is

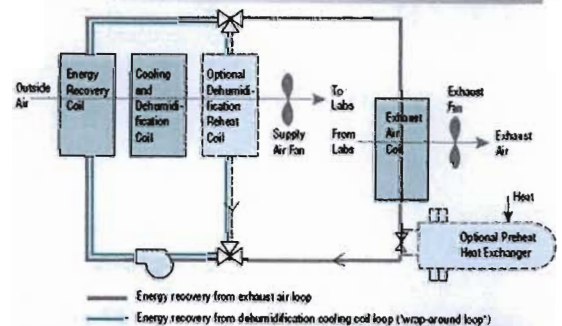


Illustration 7.12: A diagram of energy recovery in an air-conditioning system. Due to some laboratory environments requiring 100% outside air, energy consumption is high; therefore recovery should be a serious consideration. Source: (Wirdzek: 2003, 4)



Illustration 7.13: In modern laboratories, electronic equipment is becoming more and more commonplace as it gives a quicker and more accurate result. Research environments should cater for this phenomenon. Source: (Griffin: 2000, plate 13)

informed by the services and vice versa. The design of the services should cater for the initial demands at maximum loads and at least have additional 25% capacity. (Loring: 1986, 70, Watch: 2002, n.p.)

Within the laboratories, the services supplied should have easy connects/disconnects. (ill 7.14) (Watch: 2002, n.p.) Service shut-off valves should be easily accessible and clearly marked. (Watch: 2002, n.p.) The placement of valves on lines should also allow for individual spaces to be isolated without shutting off the supply to the rest of the laboratory spaces. (Loring: 1986, 73) All piped services and their outlets should be clearly identified and colour coded using the DIN standard colour. (Griffin: 2000, 81) A design consideration is that service lines be installed in parallel to each other with the minimum amounts of joints and elbows. (Loring: 1986, 73) Equipment zones and services are usually finalised and fitted out when research teams occupy the space to suit their individual needs (Watch: 2002, n.p.), therefore main service lines and branch lines only should be initially installed (Griffin: 2000, 47).

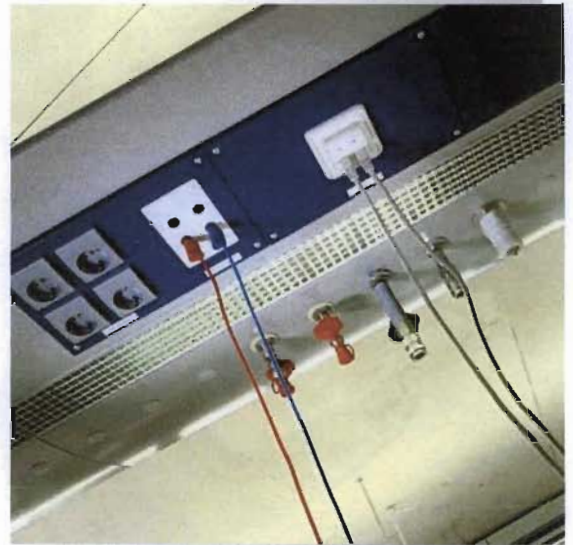


Illustration 7.14: The service carrier running above the workbench has easy connects / disconnects. When a researcher requires a supply, they merely reach up and plug into the line.

Source: (Waldner Firmengruppe: n.d., 36)

The costs associated with providing services in high-tech laboratories can amount to 48% of their total cost, excluding external works. By decentralising these services, savings can be achieved. (Griffin: 2000, 85)

### 7.5.2 Typical distribution

According to Loring (1986, 69), there are 4 major types of services distribution to the laboratories, namely:

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

#### 7.5.2.1 Continuous End –Wall Service Corridors

This distribution model generally follows a horizontal distribution system in a dedicated zone, and is very similar to a horizontal distribution system, but the major difference is that there is an enclosed zone in which services run. (ill 7.15) Each laboratory

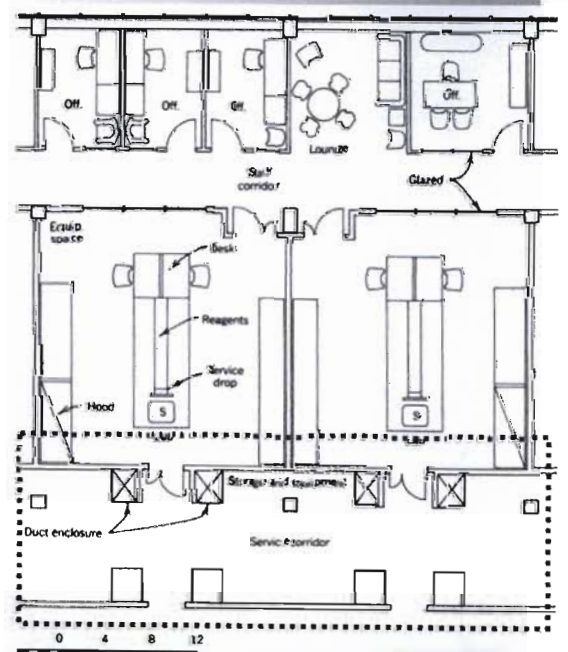


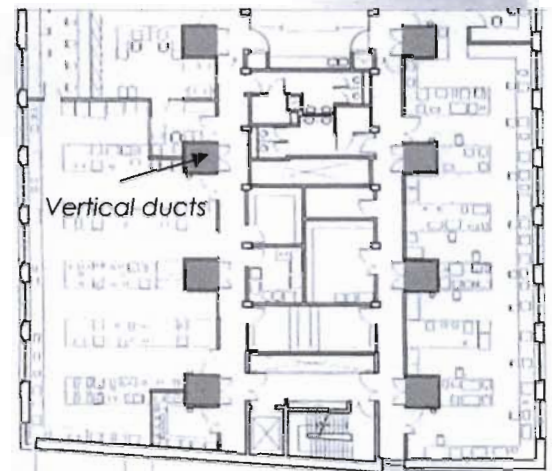
Illustration 7.15: A sectional plan of a laboratory using a Continuous End – Wall Service Corridor (highlighted area). The laboratory has become totally interstitialised.

Source: (Putnam Gould: 1986, 63)

has direct access to utilities. The system allows for flexibility, ease of maintenance, ease of modification, and reduces the floor to floor height. (Loring: 1986, 69) The enclosed zone does create a barrier within the laboratory volume, or a situation where the laboratory wall is no longer an exterior wall. This situation does not allow for the possibility of utilizing natural daylight easily, as it creates an internalised volume.

#### 7.5.2.2 Vertical distribution

This model has vertical utility zones at regular intervals within the laboratory with horizontal run outs above or below the floor slab. (ill 7.16) This system allows for lower initial costs and minimum floor to floor heights. It is however relatively inflexible and costly to maintain and modify. (Loring: 1986, 69) This system was popular in laboratory design at one stage, but has now fallen out of favour particularly due to the fire hazard posed by the numerous vertical ducts. (Seitter: 2007)



*Illustration 7.16: A sectional plan of a laboratory using vertical service distribution (vertical shafts hatched). Though initially costs are low, service layouts are inflexible and costly to maintain. The ducts also create a fire hazard.  
Source: (Griffin: 2000, 154)*

#### 7.5.2.3 Horizontal Distribution

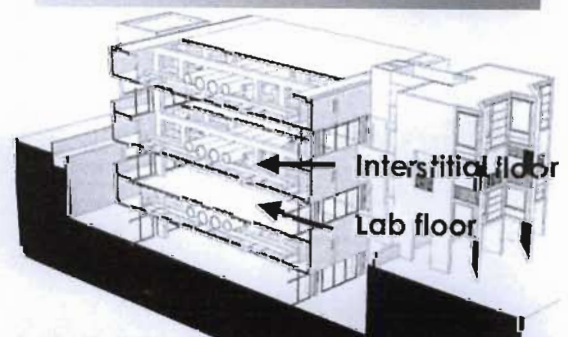
This model has major service lines that are grouped and run at the ceiling level and tapped off where required (ill 7.17). Services in the laboratories themselves are on overhead service carriers hung from the underside of the structural floor system and usually feature quick connect / disconnect fittings. (Watch: 2002, n.p.). The system is highly flexible and simple. It allows for the ability to group systems horizontally in order to control safety, energy consumption, hours of operation and security. Though it has a higher initial cost for implementation and has a higher floor to floor requirement, it offers the lowest life cycle costs. (Loring: 1986, 70, Seitter: 2007)



*Illustration 7.17: A horizontal service distribution is used in the Block H Physics Laboratories. Service runs are grouped together and run along a service ladder that is suspended from the underside of the ceiling. The system is highly flexible and cost effective.*

#### 7.5.2.4 Interstitial Floors

This model, made popular by its use at the Salk Institute, utilises a service floor that intersperses a laboratory floor. This system allows for the greatest flexibility, ease of maintenance and modification. It does however significantly increase the structural cost of the building as it adds more than 20% to the volume of the building. (Loring: 1986, 9, 69) This additional cost in light of other methods providing adequate levels of servicing has made this a less favoured system to implement.



*Illustration 7.18: A sectional perspective through a laboratory wing at the Salk Institute. An entire floor dedicated to services is located above each floor of laboratories. This is the ultimate in flexible servicing, but is prohibitively expensive.  
Source: (Leslie: 2003, 111)*

"Because of the added cost of this method of distribution, the Public Health Service (PHS) [of the United Kingdom] has taken a position recommending against its use for PHS laboratories" (Loring: 1986, 69)

### 7.5.3 Gas supply

Gases that are used frequently and/or in large volumes are generally piped to the laboratory workbench from a central storage facility. Less used gases will usually be supplied by a small cylinder on a trolley being delivered to the workbench. According to Loring (1986, 73), the requirements for a central gas storage area are as follows:

- It is outdoors and above ground;
- It is protected from overheating, for example shading it from direct sunlight; and
- It is located away from other combustible sources of potential sources of ignition, such as power lines.

Gasses most frequently used in a laboratory include: butylene, carbon dioxide, hydrogen, helium, oxygen, nitrogen, propylene, propane and natural gas. (Loring: 1986, 91) The individual research programs will dictate the exact supply. A service system that allows for the easy installation of a new gas run as required, such as a horizontal system, is advantageous. Materials used for piping need to be totally inert to the piped contents. Materials for consideration include refrigeration grade copper tubing, stainless steel, polypropylene and Acrylonitrile-Butadiene-Styrene (ABS) piping. (Griffin: 2000, 80)

### 7.5.4 Water supply

There are three types of water systems that may be installed in a laboratory, subject to the needs of the research programs. (Griffin: 2000, 77, 80) These are:

- Potable –  
Hot and ambient water is supplied for general use and hot water can be derived from solar water heaters. (ill 7.19)
- Non-Potable –  
Hot (60°C) and ambient temperature water is reticulated to laboratory fixtures.



Illustration 7.19: In South Africa's climate, solar water heaters are very effective. Hot water for general use in the laboratories and in the rest of the facility can be generated using this low impact source.  
Source: (freeheat: n.d.)

- Analytical grade –

This is higher grade water reticulated at ambient temperature to laboratories for use in sensitive experiments. This system is a continuous loop supply to reduce the risk of contamination and requires that dead legs be kept to a minimum.

The main water supply should flow into a 'break tank' or have back flow prevention devices to prevent contamination. Filtration units should also be installed to protect the supply from blockages. The mechanical engineer concerned will consult on the option to use. (Griffin: 2000, 46, 77)

All outlets should be fitted with flow control devices and the tapware throughout the facility should be constant and of the highest quality. This will assist in conserving water, eliminate water hammer, and provide reliable and predictable flow control. The consequences of reduced water consumption will be to reduce maintenance costs, and the consumables used in treating the water supply and the effluent discharged. (Griffin: 2000, 77, 80) Mains hot water runs should also be insulated to reduce consumption of water and energy. (Griffin: 2000, 79) All non-potable water outlets should be marked as such. (Griffin: 2000, 81)

As with the gas supply, water for use in laboratories needs to be reticulated in inert matters such as polypropylene (stabilised polypropylene is required for hot water supply), ABS Piping and refrigeration grade copper piping. The jointing is to be carried out using a proprietary electro fusion technique. (Griffin: 2000, 79) The supply should be flexible in that it should provide for easy adaptation. Pipes should be sized to allow for spare capacity to cope with varying usages. (Griffin: 2000, 81)

Should water be supplied to a high hazard area, this would require individual, zone and site protection to ensure that the potable water supply is not contaminated. (Griffin: 2000, 81)

### 7.5.5 Fume extraction

The trend in modern laboratory design is to limit potential hazardous or fume producing processes to contained areas such as fume cupboards or biological safety cabinets. The location of fume cupboards should ideally be at a perimeter window wall away from a fire escape route, especially since they are usually fixed items. (Griffin: 2000, 50) These fume cupboards are best if mounted on a metal frame. This allows for operators to sit comfortably with space for their knees beneath it and allows for easy access for repairs and cleaning. (ill 7.20)(Griffin: 2000, 45) Where equipment generates a significant volume of heated air, or where other fumes are generated outside of a fume cupboard, an adjustable hood linked to the air extraction system (ill 7.21) should be used otherwise it will mix with the general laboratory air. This will in turn necessitate a higher exchange rate of the general laboratory air and increase energy consumption. (Griffin: 2000, 53).

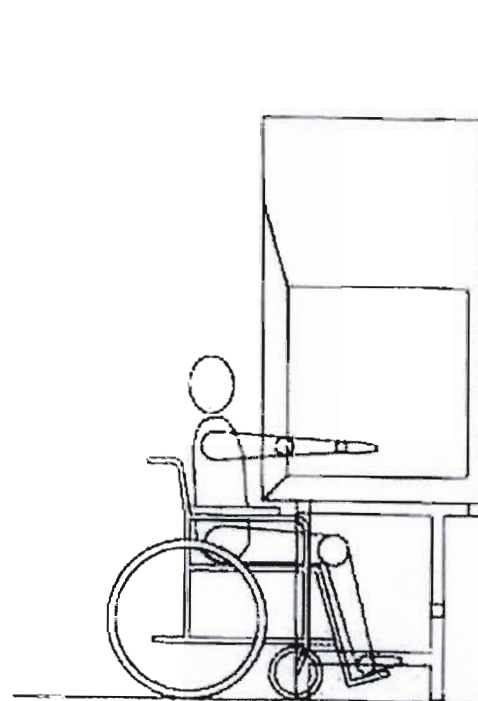


Illustration 7.20: The laboratory environment is no different from other working environments in that it should cater for wheelchair users. A fume cupboard on a metal frame allows for a wheelchair bound person to operate it. Source: (Griffin: 2000, 43)

### 7.5.6 Laboratory waste

The laboratory environment can produce hazardous and toxic waste in the form of vapour, solids, and liquids. All these wastes need to be dealt with in the design to ensure safe disposal.

#### 7.5.6.1 Liquid waste

Liquid wastes that may contain acids typically drain into a dilution pit before being discharged into the municipal sewer system. Alternatively it could drain into a holding tank to be physically removed by a waste management contractor. (Griffin: 2000, 47, 67) It could also drain into a sump filled with limestone chips to raise the pH to a level suitable for discharge into a sewer. (Loring: 1986, 85) All solvent waste must be disposed of in a dedicated sink that drains to a mechanically ventilated tank or be placed in containers and kept in stores for collection by specialist contractors. (Griffin: 2000, 67) Any waste that may be radio-active needs to have dedicated piping draining into a holding tank for disposal by specialist contractor. The piping should not run on or in occupied room. If it does, the pipes should have lead shielding. Highly infectious



Illustration 7.21: Where heat or fume generating processes are not restricted to a fume cupboard, an adjustable hood can be connected into the laboratory exhaust service. Source: (Waldner Firmengruppe: n.d., 40)

waste is similarly treated, without the need for lead shielding. (Loring: 1986, 89)

The piping used needs to be chemically resistant and types of material that can be used are ABS piping, high density polyethylene, vitrified clay with acid-resistant neoprene ring joints inground and Pyrex glass with stainless steel couplings. (Griffin: 2000, 47, 81) Where wastes cannot discharge through the floor, pump-out and vacuum extraction systems can be employed. (Griffin: 2000, 47)

#### 7.5.6.2 Solid waste

Infectious solid waste, sharps, laundering and the like are to be disposed of in containers in the laboratory and then removed to be stored for disposal by specialist contractors. (Griffin: 2000, 67)

#### 7.5.6.3 Gas waste

Contaminated air needs to be contained within the laboratory environment. This is usually done by restricting processes that produce contaminated air to fume cupboard, biological cabinets or other such equipment. This air then needs to be treated (chemically, incinerated or filtered) before being released into the atmosphere. The usual practice is to have air intake at ground level and air exhaust at roof level (ill 7.22) to avoid expelled air from being reintroduced into the system. (Loring: 1986, 72)

#### 7.5.6.4 Glass washing

Centralised glass washing facilities in more modern laboratories replace basins on workbenches within the laboratory environment. Used glassware is collected regularly from the laboratory space to be cleaned in the central facility. (ill 7.23) By eliminating the need for sinks to cater for glass washing in the laboratory, valuable bench space is freed up and water splashing is minimised. There are still small sinks that are included, but these can be closer to tasks being conducted and are therefore more convenient. (Griffin: 2000, 45)

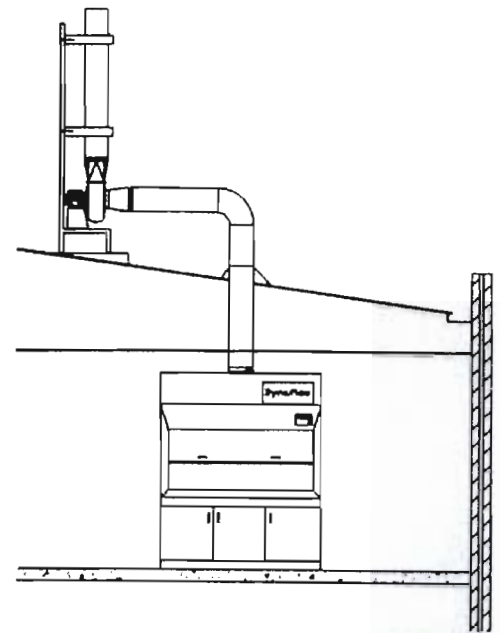


Illustration 7.21: As illustrated by this sketch of a fume cupboard, fumes are usually exhausted at roof level.

Source: (Griffin: 2000, 51)

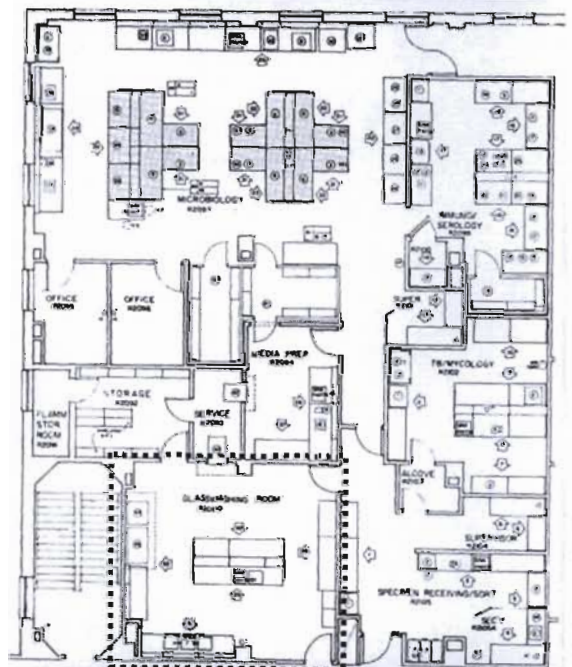


Illustration 7.22: Modern laboratories tend to do away with glass wash facilities in the laboratories themselves, but rather have it centralised to free up space in the highly serviced laboratory areas. Highlighted above on the plan is a central glasswash room

Source: (Koenig: 1985, 142)



7.5.6 Workbenches

The trend in many new high tech laboratories is to have mobile casework except for items that require fixing, such as fume hoods and sinks. (Watch: 2002, n.p.) Worktops are usually on steel frames with movable cabinets and storage that slot in beneath. (ill 7.23) By easily being able to reconfigure the casework, individual researchers can interchange between locations and the environment responds to individual and group needs as they arise.

With the increasing mechanisation of the research environment, more equipment may be required in the laboratory. Service installations that are fixed to the workbench make the services and the workbench difficult to change, therefore in an environment needing to be flexible, this should be avoided. (Putnam Gould: 1986, 62) By installing mobile casework, workbenches can easily be removed to make space for large pieces of equipment. Shelving attached to the workbench can also be more easily modified if there are no services attached to it. (Griffin: 2000, 40) Mobile casework also allows the option of having height adjustable worktops which allows for easy modification to suit the requirements of the individual researcher or equipment. It is also easier to clean the floor under a workbench if it is movable and raised. (Griffin: 2000, 67; Koenig: 1985, 157) In addition, height adjustable workbenches and fume cupboards allow wheelchair users to better use resources. (Griffin: 2000, 56)

Laboratories with wet processes need continuous fixed workbenches to contain spills. Flexibility can still be achieved by benches being supported on a metal frame as opposed to the cupboards beneath. (Griffin: 2000, 39)

Though the trend for instruments is to have built-in vibration isolating bases, the use of anti-vibration benches should be used to isolate sensitive equipment from structure borne vibrations. (Griffin: 2000, 54)

Workbenches can typically be arranged in two configurations, namely Island (ill 7.24) and peninsula (ill 7.25). Island benches

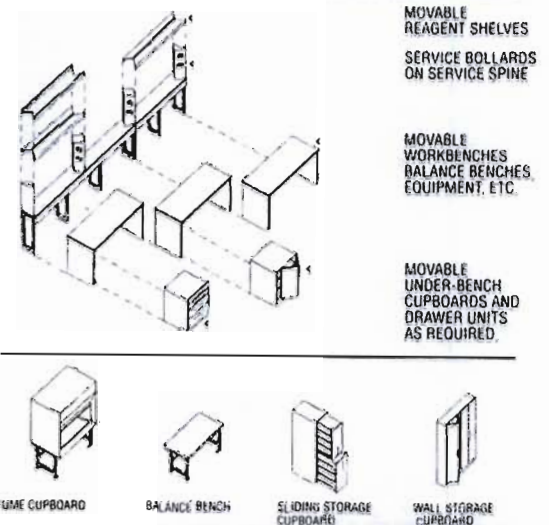


Illustration 7.23: This particular system of casework was developed by Brian Griffin. The general principles of movable components are limited by the fact that a fixed service spine still exists. An overhead service carrier would not be so limiting. Source: (Griffin: 2000, 151)

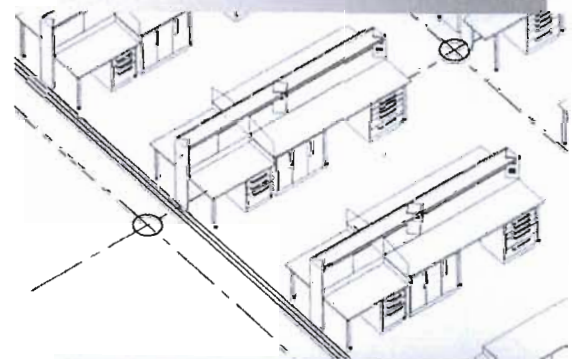


Illustration 7.24: A typical Island workbench arrangement. Running services to the benches is more difficult, but in a larger laboratory environment, it does facilitate movement. Source: (Griffin: 2000, 7)

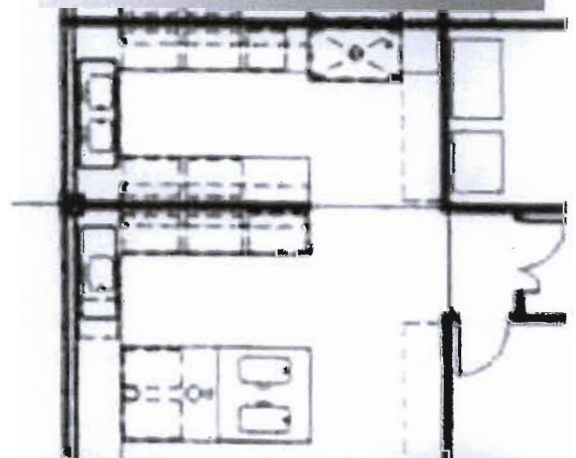


Illustration 7.25: Peninsula workbenches form a 'U' shape and are easily serviced from the wall. They also create bays free from traffic. Source: (Griffin: 2000, 135)

are more difficult to service, particularly with drainage runs. (Putnam Gould: 1986, 62) The advantage that they lend is ease of circulation with two circulation routes as opposed to a peninsula workbench configuration with only one circulation route. Peninsula benches can be easily serviced from the wall and create bays that are free from traffic. In addition the configuration results in the highest total bench length to floor area. (Griffin: 2000, 33) In terms of placement of sinks, most users seem to favour having them next to the major circulation route. (Griffin: 2000, 33)

### 7.5.7 Ventilation

Typically, the laboratory environment requires 15 – 25 air changes per hour due to the excessive heat loads generated by the equipment intensive environment and the removal of odours and gasses that may be created. (Loring: 1986, 75) Plants and ducting should be designed to cater for the increased requirement and allow for flexibility due to potential changes in use. This flexibility may be best achieved by a decentralised plant system as opposed to a central system. (Griffin: 2000, 71)

### 7.5.8 Electrical supply

Except where equipment may draw heavy loads, approximately 80% of the laboratory environment can be serviced by a standard 220V system. The laboratory loads should be kept separate from all other building loads. A dedicated distribution board should be installed for every 55m<sup>2</sup> of laboratory space and should be located outside of the laboratory space proper. (Loring: 1986, 73) (ill 7.26)

To cater for future changes, Loring (1986, 74) suggests the following should be allowed for:

- 25% spare capacity in the service and distribution facility;
- spare duct banks in the service runs;
- reserved space to add equipment and run additional feeders; and
- runs arranged to be accessible over their entire length.



*Illustration 7.26: An electrical distribution board outside a laboratory space at the Block H Physics laboratories, Westville campus, UKZN. Notice the spare space for more circuit breakers to allow for future growth of servicing requirements.*

The electrical system should include a back-up generator supply. Where environments cannot tolerate an interruption in power, they should be connected to an 'Uninterrupted Power Supply' system. Steel cable trays, rather than aluminium, should be considered as they produce minimal electronic interference. (Loring: 1986, 74)

#### 7.5.9 Hazardous materials

Where pathogens are involved in laboratories, cross-contamination needs to be eliminated. According to Putnam Gould (1986, 58) the specific spaces need to be treated in the following manner:

- Clean rooms be provided with positive air pressure;
- Negative pressure and prohibition of recycling air from contaminated areas;
- Allow for adequate ventilation rates in spaces;
- Installation of high efficiency filters; and
- Inclusion of air locks and decontamination areas as required.

The amount of hazardous materials needs to be limited within the laboratory environment. This can be achieved by using a central store separate from the laboratories, and is highly recommended. A daily quantity can then be dispensed to the laboratories. Flammable liquids, such as reagents, should be stored in a specifically manufactured cabinet. (ill 7.27, 7.28) An alternative is a trolley cabinet that can be wheeled out of the laboratory when not required and stored elsewhere. (Griffin: 2000, 54)

#### 7.5.10 Fire systems

Due to the higher risk environment, the combination of a fully automatic wet pipe sprinkler system and complete fire stand pipe should be installed in the laboratories. (Loring: 1986, 91)



Illustration 7.27: Flammable material needs specific storage. Typically in less specialised and sensitive laboratories, a designated steel cabinet suffices, as seen above in one of the CSIR Durban campuses laboratories.

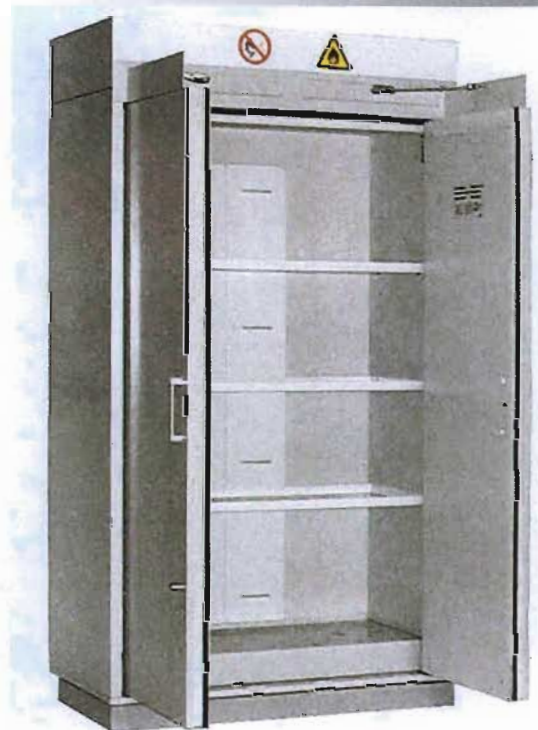


Illustration 7.28: In a more sensitive and volatile environment, more stringent flammable storage is advisable. Specifically designed cabinets that are linked to the laboratory exhaust air system should be considered.  
Source: (Waldner Firmengruppe: n.d., 48)

**7.6 Safety**

**7.6.1 General**

Safety within the laboratory environment is one of the most important aspects due to the higher risk it poses. (Griffin: 2000, xi) In purely capitalist terms, it stands to reason that since vast resources are being called upon in the construction and operation, staff and facilities should be protected from all manner of injury or damage that may lead to their inability to perform tasks for any amount of time and thus reduce the output of research.

**7.6.2 Safety equipment**

Primarily, safety equipment for laboratories includes fire fighting and accident equipment. The portable extinguishers and fire hose reels, safety shower (ill 7.29) and face and eye wash (ill 7.30) should ideally be consolidated and located within the laboratory space along the main circulation route within maximum permissible travel distances. By placing them along the major circulation route, there will not be a tendency for access to be obstructed. (Griffin: 2000, 34)

**7.6.3 Planning**

The laboratory environment is a higher risk area and any uninformed person can become a hazard not only to themselves but also to the laboratory itself. Laboratories need to be separated from the more public domain where visitors and other uninformed persons may be. A situation with a physical barrier with a limited number of access points that are controlled should be implemented. (Griffin: 2000, 16) The laboratories need to have fire rated isolation between themselves and their surrounding functions due to the higher fire risk that they pose. (Griffin: 2000, 27)

**7.7 Structure**

The structural requirements of the laboratories themselves are more specialised than for the rest of the facility, therefore the recommendations pertain specifically to them.

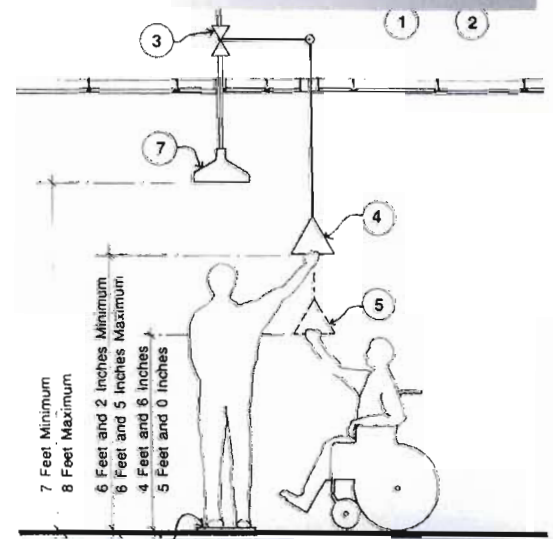


Illustration 7.29: In an environment where hazardous spills can occur, a safety shower should be included in a laboratory space. The diagram above shows one that can also be operated by wheelchair users.

Source: (Diberardinis et al.: 1993, 480)



Illustration 7.30: A laboratory eye wash station at the CSIR, Durban campus laboratories. Ideally this should be consolidated with a safety shower.

The most suitable floor plan for a laboratory is rectangular and built on a 3m grid due to the configuration of the workbenches. (Griffin: 2000, 28) The 3m grid can further be divided into a 1.5m module. (ill 7.31) Structural columns must not impinge on the laboratory floor space as this would cause special casework needing to be constructed and reduce flexibility of the space and fittings. (Griffin: 2000, 30) Corridors should be no less than 1.5m wide and door opening should be recessed. If they are much wider than this, the excess space may be used for storage, which may in turn create a hazard. (Griffin: 2000, 33)

There should be a minimum of 2.7m from the floor to the underside of a fixture or ceiling and thereafter an additional 1 to 1.5m may be required for structural, mechanical and electrical systems. (Putnam Gould: 1986, 62) The overall height should be kept to a minimum to reduce the volume of environment that needs to be artificially controlled and thereby impact on energy consumption. (Griffin: 2000, 28)

**7.8 Illumination**

**7.8.1 Requirements**

For most tasks a level of 500 lux across the workbench is appropriate. More demanding tasks may require more light, but this can be supplemented with local lighting as required. (Griffin: 2000, 34, Watson: 1986, 93) Though indirect natural day-lighting is encouraged, no direct sunlight should fall on the workbench. (Griffin: 2000, 27) If no task lighting is provided, overhead light fittings should be perpendicular to limit shadows being cast on the work surface. (ill 7.32) Workbenches should be perpendicular to the windows for the same reason. (Koenig: 1985, 158)

Emergency lighting must also be incorporated, especially where escape routes change direction. This should operate on an independent power supply. Emergency lights with integrated power packs work well in this regard. (Watson: 1986, 102)

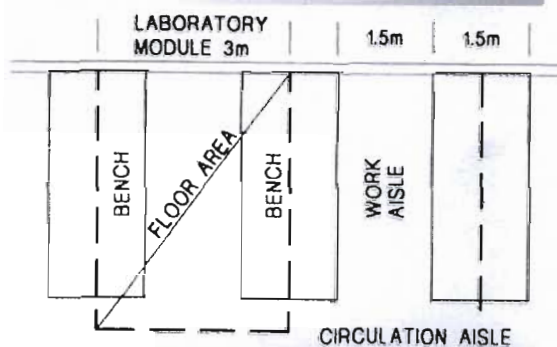


Illustration 7.31: A standardised module of 1.5m is recommended for the laboratory layout. By complying with an international standard, discrepancies between imported equipment and casework should be avoided and components are easily interchangeable. Source: (Griffin: 2000, 21)



Illustration 7.32: Overhead lighting should be perpendicular to the work surface to minimise shadows being cast. Many laboratories have them parallel and placed above the centre of the aisle between work benches, which is not ideal. Source: (Koenig: 1985, 158)

The architect should not neglect exterior lighting. Illuminating the building and its surrounds should be considered. (Watson: 1986, 102) Appropriate lighting not only assists in providing for a more secure and safer environment, but also enhances the appearance of the building at night.

### 7.8.2 Natural day-lighting

Natural day-lighting should be the primary source of illumination where possible. Artificial lighting should be viewed as a supplement rather than a replacement. By maximising the use of day-lighting, not only is energy consumption reduced, but it increases comfort and enhances productivity of building users. (Watch: 2002, n.p.) (ill 7.33) The placement of windows should be integrated so that from almost anywhere people have an opportunity to look outdoors. This gives the user the opportunity to relax ocular muscles from intense concentration when working at a desk or workbench by being able to focus on a distant object or scene. A ratio of 20 – 30% of glazing to wall area is recommended. (Watson: 1986, 93)

Skylights can also be incorporated to provide natural day-lighting. (Watson: 1986, 96) They give more uniform illuminance, but solar control measures should be implemented to reduce heat gain and glare, particularly in Durban's harsh climate.

### 7.8.3 Colour considerations

A light colour should be considered for the walls, ceiling, floor and furniture as this will help to maximise inter-reflected light. (Griffin: 2000, 34) This will reduce energy consumption, the contrast between the luminance through the window and its surrounds, and will also lower the discomfort glare off the ceiling. The colours in cafeterias, restrooms and other social spaces should be considered differently as they require a different atmosphere from work spaces. (Watson: 1986, 101)



*Illustration 7.33: The inclusion of natural daylight is recommended. Not only does it reduce the requirement of artificial lighting, but improves the quality of the space. In the illustrated building, a series of stepped clerestory windows admits natural day-lighting into a large-span space  
Source: (Wirdzek: 2000, 3)*

### 7.9 Finishes

The walls and ceilings of the laboratories must be impermeable, non-porous and smooth for easy cleaning. (Furr: 2000, 103) Floors should be level and have pre-finished sheet vinyl or an equivalent specifically for laboratory use. The joints

should be welded and the sheeting should extend 150mm up the walls. (Griffin: 2000, 34) Another flooring option to consider to vinyl is natural linoleum. According to the Nairn Floors International Limited Catalogue (n.d.), it is dimensionally more stable, more resilient to scorch marks and its raw materials (primarily cork) are natural and renewable.

Internal dividing walls are usually constructed out of clay brick, concrete block or dry walling on steel studs. These need to be painted, as untreated they are relatively porous. (Furr: 2000, 104) Acrylic or urethane epoxy wall paints are appropriate for use to finish internal laboratory walls. (Bridgen: 1996, n.p.)

There are a range of new impervious materials for worktops that are easy to clean. Spills can be rubbed off with an abrasive pad without damaging the solid surface once the spill has dried. (Griffin: 2000, 39)

### **7.10 Storage**

It is critical to have adequate provisions of storage to ensure good housekeeping and thereby facilitate a safe laboratory environment. (Griffin: 2000, 13) Traditionally, materials have been stored under the workbench, on shelves behind the workbench and in full-height glass-fronted wall cabinets. This has recently changed due to increasing safety awareness. By limiting the amount of chemicals in the laboratory itself by means of having a central store, the requirement for reagent shelving and the quantity of under-bench cupboards have reduced.

Reaching down or over surfaces is hazardous, therefore full height wall storage cabinets (ill 7.34) should be used as they are safer and are a good ergonomic practice as it avoids people having to bend down and reach into deep under-bench cupboards. (Griffin: 2000, 13, 43) Cabinets should have narrow shelves to avoid stacking bottles behind each other.



*Illustration 7.34: Storage in the laboratory environment is important. Full height wall storage cabinets are a safer and more ergonomically sound option.*

*Source: (Waldner Firmengruppe: n.d., 47)*



*Illustration 7.35: The inclusion of mobile carts in the laboratory allows for very flexible storage. Equipment can also easily be moved between stations.*

Mobile carts (ill 7.35) and adjustable shelving are highly recommended for storage. Mobile carts can be stacked when not in use and facilitate easier sharing of resources. Adjustable

*Source: (Waldner Firmengruppe: n.d., 42)*

shelving can easily be modified to provide the height and space required. (Watch: 2002, n.p.)

**7.11 General aspects**

A separate goods lift is highly recommended. (Griffin: 2000, 93)  
 By moving large pieces of equipment and supplies in a standard passenger lift, damage is likely to occur to the lift. Goods lifts are larger and the finishes resist damage better.

Doors that are larger than standard should be used. A 1,5m wide access will allow for the movement of larger equipment. The door should have a leaf for regular use and a second leaf allowing for a 1,5m clear opening. (Griffin: 2000, 35, 60)

If trolleys are used within the facility, ramps and doors of sufficient width are a necessity for access. By having 1,5m wide openings, trolleys will be accommodated. (Griffin: 2000, 94)  
 Access for deliveries is important and should be well considered. (Griffin: 2000, 16)

Signs indicating potential hazards, as well as requirements to be complied with need to be placed all throughout the facility where required. The laboratories have more specific signage requirements, such as flammable liquid and acid hazards, location of safety equipment. (ill 7.36) The professional appointed to handle all aspects pertaining to safety design for the project will be responsible for this.



**7.12 Conclusions**

**7.12.1 Efficient planning**

Due to the high cost of the services installed in a laboratory facility relative to the overall construction cost, efficient planning must be a key component. Aspects to consider include:

- Rational services layout;
- Position of structure so as not to impede service supply; and
- Adoption of an internationally recognised module size.

Illustration 7.36: Due to the nature of laboratories, signs need to be used to indicate potential hazards and information. These are merely a sample of signs that need to be used. Source: (Helmenstine: n.d.)



### 7.12.2 Flexibility

The future requirements of the facility are unpredictable. In addition to this, the nature of research and the equipment required for it constantly changes. With the infrastructure installed not being easy to alter, flexibility of spaces and services are required. Aspects to consider in this regard include:

- Service systems that are easy to alter;
- Decentralisation of service plants;
- Incorporating spare capacity into services design; and
- Adoption of an internationally recognised module size to facilitate interchange of equipment and laboratory furniture.

### 7.12.3 Human comfort

In addition to providing a space that is climatically acceptable for human occupation, the facility needs to take cognisance of the social phenomenon of research. The design should cater for both visual and physical interaction by including purposeful social spaces and in the design and configuration of other spaces.

### 7.12.4 Environmental impact reduction

Due to the research processes utilizing high levels of energy and other consumables, the building design and systems implemented must reduce the impact on the environment. Particular strategies include:

- Maximising use of natural light;
- Orienting the building correctly;
- Designing an efficient building envelope; and
- Installing systems that minimise consumption and waste produced.

### 7.12.5 Specific requirements

The highly specialised nature of the research being conducted results in spaces and services to be provided having specific requirements, which have been discussed in the chapter. These include:

- Servicing;
- Safety;

- Materials;
- Finishes;
- Illumination;
- Ventilation;
- Waste disposal; and
- Storage.

---

## **Chapter 8 – Conclusions and Recommendations**

### **8.1 Introduction**

The research presented in this document up to now deals with comprehensive aspects of the design of a new cancer research institute for Durban. It indicates five main aspects should be considered in the design, namely:

- The research environment;
- The servicing strategy;
- Flexibility of the space;
- The practical requirements; and
- Environmental impact reduction.

These five aspects will be briefly reviewed and specific recommendations will also be made.

### **8.2 The research environment**

As with any other organisation, attraction and retention of high calibre staff is of great importance. To create an environment that achieves this, the design should be interactive, creative and vibrant. A pleasant built environment can be enhanced with the integration of natural features, such as distant views being exploited.

Of great importance in creating a pleasant and productive research environment is an acknowledgement that science and research is indeed a social activity and that the design should facilitate inter- and multi- disciplinary interaction that breaks down potential unequal power relationships that impact on the research output. In order to achieve this, the design should create a strong public realm within it. A shortcoming in many previous laboratory designs is that the practical mechanical requirements have overwhelmed the design and have relegated the humans that occupy the buildings to an insignificant factor. Social spaces should be seen as a necessary and integral component of the design. Particular devices, such as an internal street as a fundamental generator, can be implemented in the design to achieve this.

### **8.3 The servicing strategy**

From a merely practical point of view, the servicing strategy is the most important aspect of the design of the laboratories as it is the key to the practical success of the building. Not only is it the most expensive component of the construction process, with up to 48% of the budget being spent on it, but it also has a direct impact on the serviceability and flexibility of the building. This in turn has ramifications on the short and long term feasibility of the building.

There are four main types of distribution. Interstitial service floors offer the greatest flexibility, but due to their great initial cost, are no longer favoured. Vertical service distribution allows for a lower initial cost, but their reduced flexibility and the fire hazard they pose leads it to be unsuitable. Continuous end-wall service corridors create an enclosed zone, and thus create a barrier between the laboratory and an outside wall. Horizontal distribution has service lines running along the ceiling and tapped off where required. This system is highly flexible and simple and offers the lowest life cycle costs; it is therefore most suited to be implemented in the design.

In addition to the service reticulation system, service plants should be decentralised. Not only does this allow for the impact of an off-line plant to be reduced, but also reduces costs as runs are reduced and individual plants are only operated when required.

### **8.4 Flexibility**

The research environment is a constantly changing one. Research programs have a limited lifespan and technology is rapidly evolving. The requirements in a laboratory quickly become outdated, whether it is the service provision or layout. A key component for future feasibility of the institution is the ability of the building to easily be modified. Mobile casework within the laboratory environment and the implementation of the internationally used 1,5 meter module size allows for easy reconfiguration and equipment installation.

### **8.5 Practical requirements**

The laboratory environment itself has numerous and very specific requirements, mainly outlined in Chapter 7. Not only is supply of gas, liquid and solid consumables important, but also the disposal of the by-products. Specific attention also needs to be given to the materials in which the services are supplied, as any form of contamination is not permitted in this demanding environment.

There is an increasing awareness of safety of the staff within the laboratories and for the greater environment in which the laboratory is located. Potentially hazardous environments are restricted, hazardous processes contained and surveillance increased. Specific safety equipment need to be included and other safety requirements complied with.

### **8.6 Environmental impact reduction**

Laboratory facilities, with their high service requirements, consume five times more energy and water than a typical office building. It is therefore of paramount importance to implement strategies that reduce the impact that the facility will have on the environment. This is typically achieved by two means; maximising the use of natural opportunities and minimising the use of consumables.

Simple opportunities such as correct orientation, harnessing natural daylight, shading and implementing an appropriate building skin should be implemented. The amount of resources consumed needs to be reduced, and strategies for efficient use of water and energy must also be implemented. Reducing the volume of intensely serviced spaces should also be implemented, such as limiting laboratory ceiling height. Energy recovery systems in air handling units and other systems and grey water harvesting should also be exploited.

### **8.7 Concluding remarks**

The nature of the cancer research institute and laboratory lends itself to daunting service requirements, and these can become dominant in the design process. One must not forget that this, like any other building, is used by people. Scientists have physical requirements that services need to supply, but these services are subservient to people that occupy the facility, and these people are social by nature. Of all the case and precedent studies, Schlumberger Cambridge Ltd seems to be the most successful due to its simplicity of layout and the fundamental acknowledgement of the people that work there in the design.

---

## **Chapter 9 - Bibliography**

### **8.1 Books and journals**

Anderson, G. (1991) The Century Club. *Architectural Record*. July 1991, pp 136 – 139.

Benedikt, M. (1993) Between Beakers and Beatitudes. *Progressive Architecture*. October 1993, pp 53 – 54.

Boles, D. (1985) Roger's U.S. Debut. *Progressive Architecture*. September 1985, pp 69 – 74.

Braybrooke, S. (1986) Design in Practice: Six Laboratories. In S. Braybrooke (ed.) *Design for Research, Principles of Laboratory Architecture*. New York: Wiley, pp 104 – 159.

Bridgen, M. (1996) *Designing a Plant Micropropagation Laboratory*. Connecticut: University of Connecticut

Coetzer, N. (2007) The Good Architect is a Mad Masai Scientist. *Architecture South Africa*. July / August 2007, pp 86 – 89.

Cooke, J. (ed.)(1984) Oppenheimer Life Sciences Complex. *Architecture SA*. September / October 1984, pp38 – 46.

Crosbie, M. (1993)a The Salk Institute: Appraising a Landmark. *Progressive Architecture*. October 1993, pp 41 – 46.

Crosbie, M. (1993)b A Talk with Salk. *Progressive Architecture*. October 1993, p 47.

Crosbie, M. (1993)c Add and Subtract. *Progressive Architecture*. October 1993, pp 48 – 50.

Davey, P. (1990) Musique Concrete. *Architectural Review*. September 1990, pp 59 – 67.

Davey, P. (1998) The City in the Wilderness. *Architectural Review*. August 1998, pp 36 – 45.

---

Diberardinis, L., Baum, J., First, M., Gatwood, G., Groden, E., Seth, A. (1993) *Guidelines for Laboratory Design: Health and Safety Considerations*. New York: Wiley.

Dietsch, D. (1996) Neurosciences Institute, La Jolla, California. *Architecture*. March 1996, pp 87 – 92.

Duffy, F. (1990) Masters of Change. *Architect's Journal*. 13 June 1990, pp 26 – 31.

Freiman, Z. (1995) The Brain Exchange. *Progressive Architecture*. April 1995, pp 76 – 85.

Furr, A. (2000) *CRC Handbook of Laboratory Safety*. Fifth Edition. CRC Press

Giles, B. (1991) RIBA Awards 1990. *RIBA Journal*. January 1991, pp 41 – 43.

Giovannini, J. (1996) The Salk's New Neighbours. *Architecture*. March 1996, pp 73 – 80.

Griffin, B. (2000) *Laboratory Design Guide*. Oxford: Architectural Press.

Groák, S. (1985) Appraisal – Schlumberger Research Ltd. Cambridge. *Architects' Journal*. 18 September 1985, pp 44 -59.

Hannay, P. (1985) A Glimpse of Tomorrow. *Architects' Journal*. 15 May 1985, pp 28 – 31.

Harrell, G. (1974) *Planning Medical Center Facilities for Education, Research and Public Service*. Pennsylvania State University Press.

Haward, B. (1984) Hopkins at Cambridge. *Architects' Journal*. 1 February 1984, pp 40 – 47.



Herzberg, H. (1984) High Flyer. *Architects' Journal*. 24 October 1984, pp 43 – 63.

Hertzberger, H. (1999) The Mechanism of the Twentieth Century and the Architecture of Aldo van Eyck. In V. Ligtelijn (ed.) *Aldo van Eyck, Works*. Basel: Birkhäuser. pp 22 – 25.

Hoffrichter, D. (1973) The Rand Afrikaans University Laboratories – Approach to design. *Planning & Building Developments*. March – April 1973, pp 31 – 37.

Horrocks, C. & Jevtic, Z. (2004) *Introducing Foucault*. Royston, UK: Icon Books.

Koenig, A. (1985) *Medical Laboratory Planning and Design*. Skokie, Illinois: College of American Pathologists.

Kroloff, R. (1996) Carnegie Mellon Research Institute. *Architecture*. March 1996, pp 95 – 98.

Leslie, T. (2003) Things in their best Order: Technical Aspects of the Salk Institute and their role in its Design. *Journal of Architecture*. 8: Spring 2003, pp 95 – 113.

Loring, J. (1986) Services for Research Buildings. In S. Braybrooke (ed.) *Design for Research, Principles of Laboratory Architecture*. New York: Wiley. Pp 66 – 91.

McCarter, R. (2005) *Louis I Kahn*. Phaidon.

Mqoqi, N., Kellett, P., Sitas, F., Jula, M. (2004). *Incidence of Histologically Diagnosed Cancer in South Africa, 1998 – 1999, National Cancer Registry*. Johannesburg: National Health Laboratory Service

Putnam Gould, B. (1986) Laboratory design considerations. In S. Braybrooke (ed.) *Design for Research, Principles of Laboratory Architecture*. New York: Wiley. Pp 49 – 65.

Righini, P. (2000) *Thinking Architecturally. An introduction to the Creation of Form and Place*. Cape Town: UCT Press.

---

Siegel, L. and Roth, D. (1995) *Research Laboratory Design Guide*. Department of Veterans Affairs – United States of America.

Sorkin, M. (1985) Another Low-Tech Spectacular. *Architectural Review*. (1063): September 1985, pp 38 – 41.

Strauven, F. (1999) Aldo van Eyck and the City. In V. Ligtelijn (ed.) *Aldo van Eyck, Works*. Basel: Birkhäuser. Pp 30 – 33.

Treib, M. (2006) To End a Continent. *Journal of the Society of Architectural Historians*. September 2006, pp 402 – 427.

Van Eyck, A. (1999) The Medicine of Reciprocity Tentatively Illustrated. In V. Ligtelijn (ed.) *Aldo van Eyck, Works*. Basel: Birkhäuser. Pp 88 – 89.

Waldner Firmengruppe (n.d.) High-Tech-Schulsystem II – Trade Literature Catalogue. Hamburg: Waldner. Pp 1 – 69.

Watson, N. (1986) Laboratory Lighting. In S. Braybrooke (ed.) *Design for Research, Principles of Laboratory Architecture*. New York: Wiley. Pp 92 – 103.

Weeks, J. (1986) Design Approach, A. In S. Braybrooke (ed.) *Design for Research, Principles of Laboratory Architecture*. New York: Wiley. Pp 1 – 17.

Wirdzek, P. (2000) *Laboratories for the 21<sup>st</sup> Century: An Introduction to Low-Energy Design*. National Renewable Energy Laboratory - U.S. Department of Energy.

Wirdzek, P. (2003) *Laboratories for the 21<sup>st</sup> Century: Best Practices*. National Renewable Energy Laboratory - U.S. Department of Energy.

## **8.2 World Wide Web Pages**

Allen, G. (1998) *Organizing Process. Management Modern.*  
[http://telecollege.dcccd.edu/mgmt1374/book\\_contents/3organizing/org\\_process/org\\_process.htm](http://telecollege.dcccd.edu/mgmt1374/book_contents/3organizing/org_process/org_process.htm) (Accessed 14 December 2007)

Brokaw, L. (1993) *Thinking Flat. Inc.com on-line Journal.*  
<http://www.inc.com/magazine/19931001/6095.html> (Accessed 14 December 2007)

*Cancer Research UK (2004)*  
<http://www.cancerresearchuk.org/> (Accessed 17 July 2007)

Harrison-Broninski, K. (2005) *Modeling Human Interactions: Part 2. BP Trends.* July 2005, pp 1 – 5. <http://www.bptrends.com/>

Helmenstine, A. (n.d.) *Science Laboratory Safety Signs.*  
<http://chemistry.about.com/od/healthsafety/ig/Laboratory-Safety-Signs/index.01.htm> (Accessed 14 November 2007)

Jones, R. (2004) *Laboratory Architecture – Exemplars.*  
[http://people.seas.harvard.edu/~jones/lab\\_arch/lab\\_arch.html](http://people.seas.harvard.edu/~jones/lab_arch/lab_arch.html) (Accessed 17 July 2007)

Mason, M. (2008) *Focault*  
<http://www.moyak.com/researcher/resume/papers/foucault.html> (accessed 04 September 2008)

Nakano, B. (2006)  
[http://www.foxlin.com/gallery/bryan/Louis\\_Kahn\\_Salk\\_Institute](http://www.foxlin.com/gallery/bryan/Louis_Kahn_Salk_Institute)  
(Accessed 08 December 2007)

National Health Laboratory service. (n.d.)  
<http://www.nhls.ac.za> (Accessed 20 August 2007)

National Renewable Energy Laboratory. (2007) *Laboratories for the 21<sup>st</sup> century: Energy Analysis.*  
<http://www.nrel.gov/docs/fy03osti/33410.pdf> (Accessed 17 July 2007)

Stephens, R. (2007). Fossil Fuels.

<http://www.discoveringfossils.co.uk/fossilfuels.htm> (Accessed 21 December 2007)

University of Sherbrooke (2007)

<http://www.civil.usherbrooke.ca/> (Accessed 17 July 2007)

Walljasper, J. (2006) Big Plans on Campus. *Project for Public Spaces*.

[http://www.pps.org/campuses/info/campuses\\_articles/campuses\\_bulletin](http://www.pps.org/campuses/info/campuses_articles/campuses_bulletin) (Accessed 14 December 2007)

Watch, D. (2002) *Trends in Lab Design*.

<http://www.wbdg.org/resources/labtrends.php> (Accessed 17 July 2007)

Watch, D., Tolat, D. (2007) *Sustainable Laboratory Design*.

<http://www.wbdg.org/design/sustainablelab.php> (Accessed 17 July 2007)

World Architecture News (2007) *Aerodynamic souk*, 16 January.

[http://www.worldarchitecturenews.com/index.php?fuseaction=wanappln.projectview&upload\\_id=821](http://www.worldarchitecturenews.com/index.php?fuseaction=wanappln.projectview&upload_id=821) (Accessed 16 December 2007)

Yusheng, L (2006) *Salk Institute*.

<http://images.google.co.za/imgres?imgurl=http://figure-ground.com/lvs/20061231salk.jpg&imgrefurl=http://liaoyusheng.com/archives/2006/12> (Accessed 14 December 2007)

---

### **8.3 Interviews by Author**

Barrow, D. (Project Architect, Doris Duke Medical Research Institute, East Coast Architects), 16 March 2007, Durban.

Cahi, A. (Project architectural technician for Doris Duke Medical Research Institute, East Coast Architects), 2 March 2007, Durban.

Kisbey-Green, H. (Operations and Administration Manager, Centre for the AIDS Programme of Research in South Africa, Doris Duke Medical Research Institute), 16 March 2007, Durban.

Parsons, G. (Laboratory manager – Coastal and Marine Pollution, Natural Resources and the Environment, CSIR – Durban Campus), 17 May 2007, Durban.

Seitter, G. (Project Architect, Retrofit - Block H Physics and Chemistry Laboratories, UKZN Westville Campus), 17 April 2007, Durban.

Szpak, W. (Oncology Radiotherapy Specialist, Drs Pirjol and Szpak Inc.), 24 July 2007, Durban.

Van Heerden, D. (Project Architect, Doris Duke Medical Research Institute, East Coast Architects), 9 March 2007, Durban.

Van Heerden, D. (Project Architect, Doris Duke Medical Research Institute, East Coast Architects), 3 April 2007, Durban.

Weerts, S. (Project manager – Coastal and Marine Pollution, Natural Resources and the Environment, CSIR – Durban Campus), 13 March 2007, Durban.

## Appendix A – Schedule of accommodation

### Schedule of accommodation - Cancer Research Institute and Laboratories

	Space	Quantity	Size	Total area	Space description
Laboratory Component	Laboratories	10	150	1500	Space where physical research processes are conducted. The space is partitioned and
	Lab wash up	4	15	60	Used equipment, such as glassware, is removed here to be cleaned and sterilised.
	cleaner depot	4	12	48	General cleaning equipment and supplies are stored here.
	Locker room	4	15	60	Researcher's personal belongings and personal protection equipment (PPE) are stored here.
Research Offices	open plan	150	300	2	Junior researchers involved in team research have desks in the open plan area.
	senior researcher	20	160	8	Cellularised offices for leaders of research groups.
	private offices	15	210	14	General members of research groups occupy some offices, others are temporarily used when audio and visual privacy is required.
	break-away / discussion spaces	25	100	4	Small social spaces which double as informal discussion areas for smaller groups.
Servicing	Mechanical plant rooms	1	550	550	Rooms where the plants required to service the laboratories are housed.
	Central stores	1	60	60	Storage space for bulk laboratory consumables delivered.
	External Gas storage	1	20	20	Undercover storage area open directly outdoors where cylinders supplying gas to the laboratories are housed.
	Computer server room	1	15	15	Hardware for the facility's computer network is housed here.
	Emergency generator room	1	15	15	Equipment, such as the Uninterrupted power supply batteries and the back-up generator are housed here.
	Hazardous Waste Storage	1	30	30	Waste generated in the laboratory is temporarily stored here to be removed for disposal by an outside contractor.
Administration	open plan	1	120	120	Administration clerks have desks in this area.
	senior administration staff	2	20	40	Individual cellular offices for senior administration staff.
	private offices	6	15	90	Certain administration staff occupy some offices, others are temporarily used when audio and visual privacy is required.
	break-away / discussion spaces	2	25	50	Small social spaces which double as informal discussion areas for smaller groups.
	file storage	1	20	20	Fireproof storage areas for files and data
	reception / waiting	1	40	40	Visitors to the facility enter here and report to the reception desk and wait to be escorted around or the member of staff they are visiting meets them there.
Social Amenities	Conference	2	70	140	Hosts larger staff meetings and conferences with external professionals.
	Library	1	90	90	A reference library housing predominantly periodicals and journals. Staff and visitors can come to sit and read.
	Central social space	1	250	250	This space functions predominantly as the seating space of the cafeteria.
	Kitchen	1	50	50	Food is initially stored and then prepared for serving in the cafeteria.
	Yard Space	1	36	36	Temporarily holds kitchen waste to be removed and disposed of.
<b>Total</b>				<b>3312</b>	Total area excludes circulation, ablutions and area of undercover parking.

Ablutions	Males	WC	5	As per NBR requirement for a population of up to 180.
		Urinals	11	
		WHB	8	
	Females	WC	16	
		WHB	8	
	Universal Access	WC	3	
	WHB	3		

Parking	75 Staff	Due to the high floor area to staff ratio, local council requirements of 4 bays per 100m <sup>2</sup> for the class of building will result in an over-supply of parking. The calculation for required parking has therefore being restricted to occupied areas.
	20 Visitors	

## Appendix B – Area Analysis

### Area Analysis of Precedent and Case Studies

Components	Schlumberger Cambridge Research		Salk Institute		Neurosciences Institute		Salk Institute Additions		Doris Duke Research Institute		Average	
	m <sup>2</sup>	%	m <sup>2</sup>	%	m <sup>2</sup>	%	m <sup>2</sup>	%	m <sup>2</sup>	%	m <sup>2</sup>	%
Offices	610.0	11.5	1476.0	5.1	255.0	9.4	1426.0	14.0	1309.0	27.7	1015.2	9.0
Laboratories	1244.5	23.4	9065.0	31.3	624.0	22.9	2768.0	27.1	1690.0	35.8	3078.3	27.2
Laboratory service spaces	405.2	7.6	1032.0	3.6	n/a	n/a	n/a	n/a	85.0	1.8	507.4	4.5
Discussion spaces	337.0	6.3	n/a	n/a	n/a	n/a	734.0	7.2	na	na	535.5	4.7
Mechanical plant rooms	1450.0	27.2	3896.0	13.5	284.0	10.4	1350.0	13.2	401.0	8.5	1476.2	13.0
Administration	117.0	2.2	2550.0	8.8	172.0	6.3	255.0	2.5	n/a	n/a	773.5	6.8
Library	25.4	0.5	255.0	0.9	175.0	6.4	n/a	n/a	80.0	1.7	133.9	1.2
Central social space	592.6	11.1	n/a	n/a	67.0	2.5	788.0	7.7	n/a	n/a	482.5	4.3
Circulation	466.2	8.8	10645.0	36.8	949.0	34.8	2678.0	26.2	1011.0	21.4	3149.8	27.8
Conference	78.6	1.5	n/a	n/a	200.0	7.3	220.0	2.2	150.0	3.2	162.2	1.4
Total	5326.5	100.0	28919.0	100.0	2726.0	100.0	10219.0	100.0	4726.0	100.0	11314.5	100.0

It is to be noted that the above area analysis should be used as an indication only. It has a margin of inaccuracy due to the scale of the original plans measured off of for some buildings and the function of some spaces on the plans not being able to be determined. Certain categories have a great variance between projects due to their individual design responses.

## **Appendix C – Structured Interviews outline**

### **Structured Interview: Architects**

#### Design program:

- What has been the driving design concept in the building?
- Is there any symbolic aspects taken into account in the design?
- What are your feelings in terms of function and space making integration?
- 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?
- How has security concerns and access being approached in the building?

#### Servicing:

- What has been the approach to services?
- What were the specific requirements for servicing?
- How is the long term flexibility of services addressed?
- What support spaces were included and what is their relation to the served space and to each other?
- What have been the drawbacks of the different servicing systems implemented?

#### Physical components

- What structural approach has been followed, and what influence does this have on servicing and the creation of 'human' spaces?
- How has the notion of the creation of an environment to optimize the functioning of the human mind being translated into the design of an appropriate range of micro-environments within research facilities, such as in the social, private, public, research and teaching environments?
- What has been the approach, if any, to the inevitable changing demands that the research places on the environment in which it is conducted in the short and long term?
- How has the possibility of expansion of the facility being factored into the design?
- What has been the approach to minimizing environmental impact?
- Are there any strategies that have been implemented to reduce the dependence on natural resources?

### **Structured Interview: Researchers**

#### Medical research in overview

- What is the importance of medical research in the 21<sup>st</sup> century and how does the architectural realm inform this?
- How has the architectural environment of medical research changed over the last few years?

#### Work Environment

- How do you think that the physical research environment influences you as an individual and the work that you do?
- Are there any particular humane elements within the building that you value?
- Is informal communication between researchers an important component of the environment?
- What are the special requirements in the physical environment?

#### Servicing

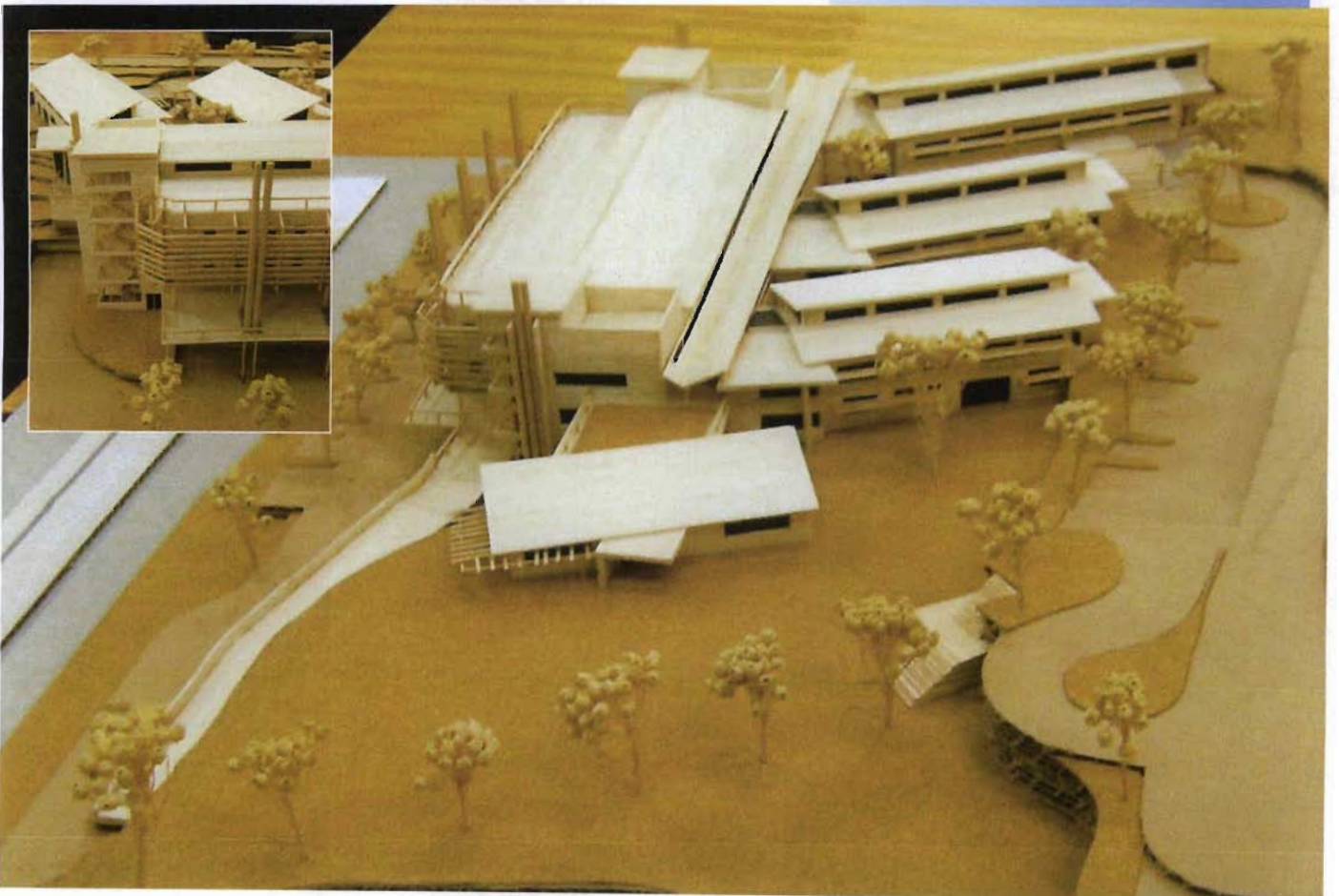
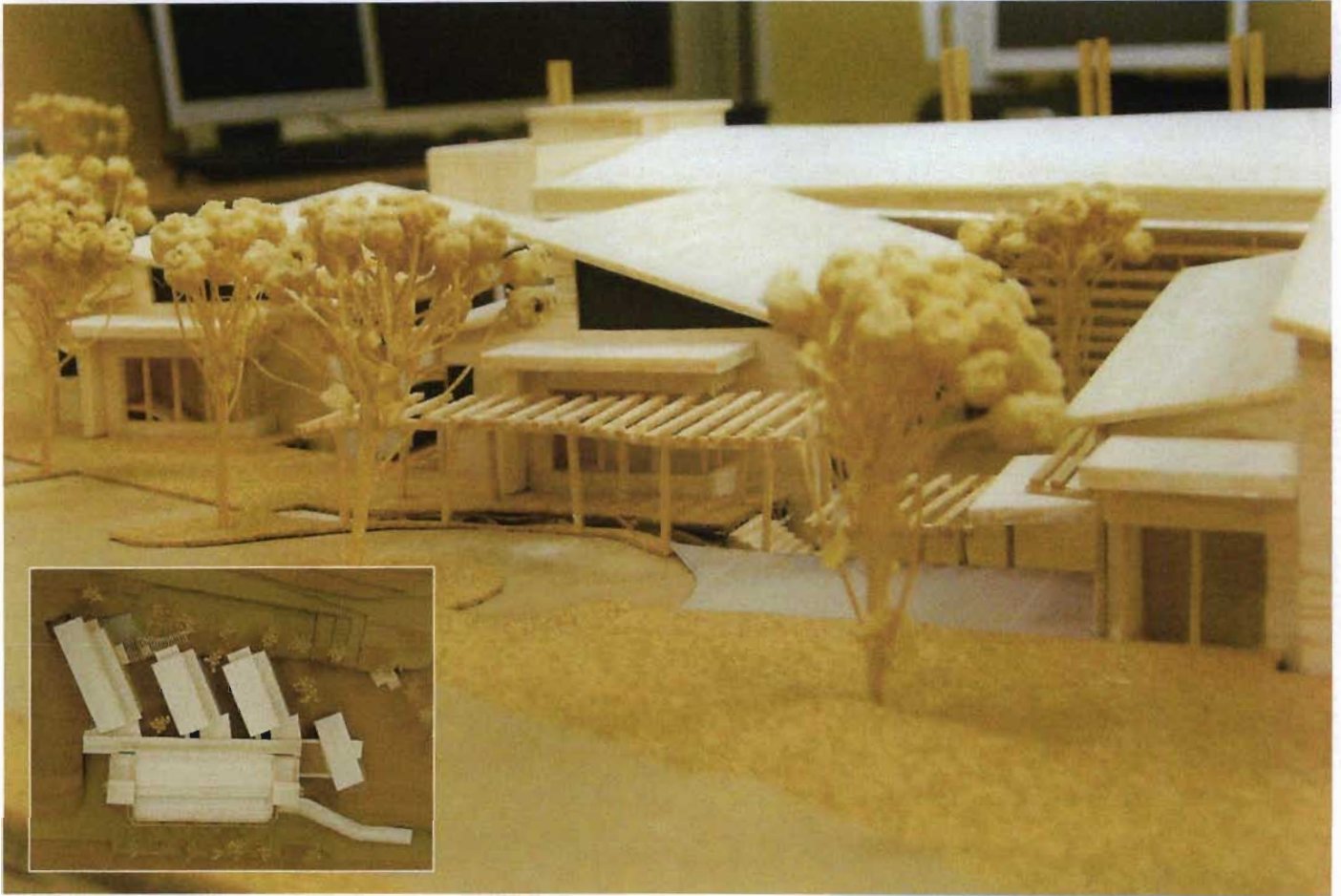
- What are your views of the design approach to servicing in the building?
- Is flexibility of servicing an important aspect of the research environment?

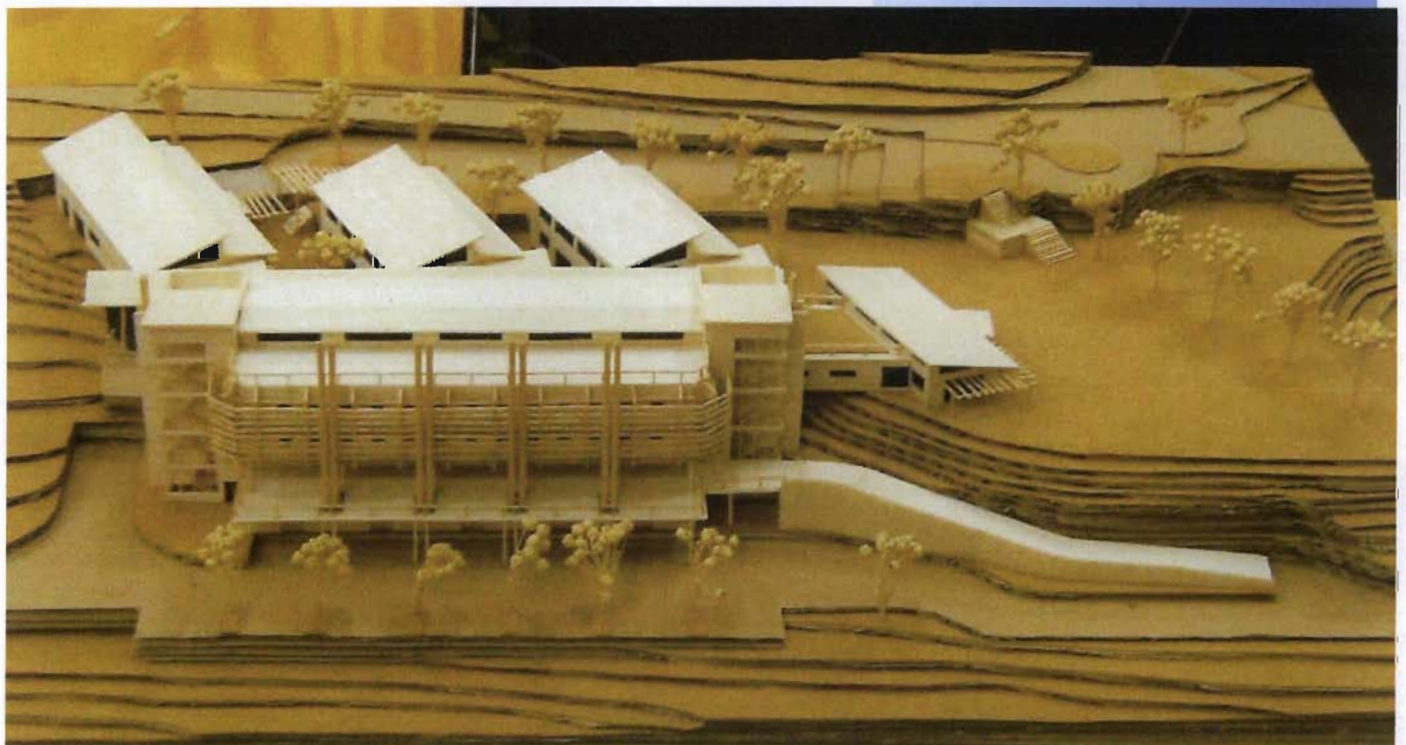
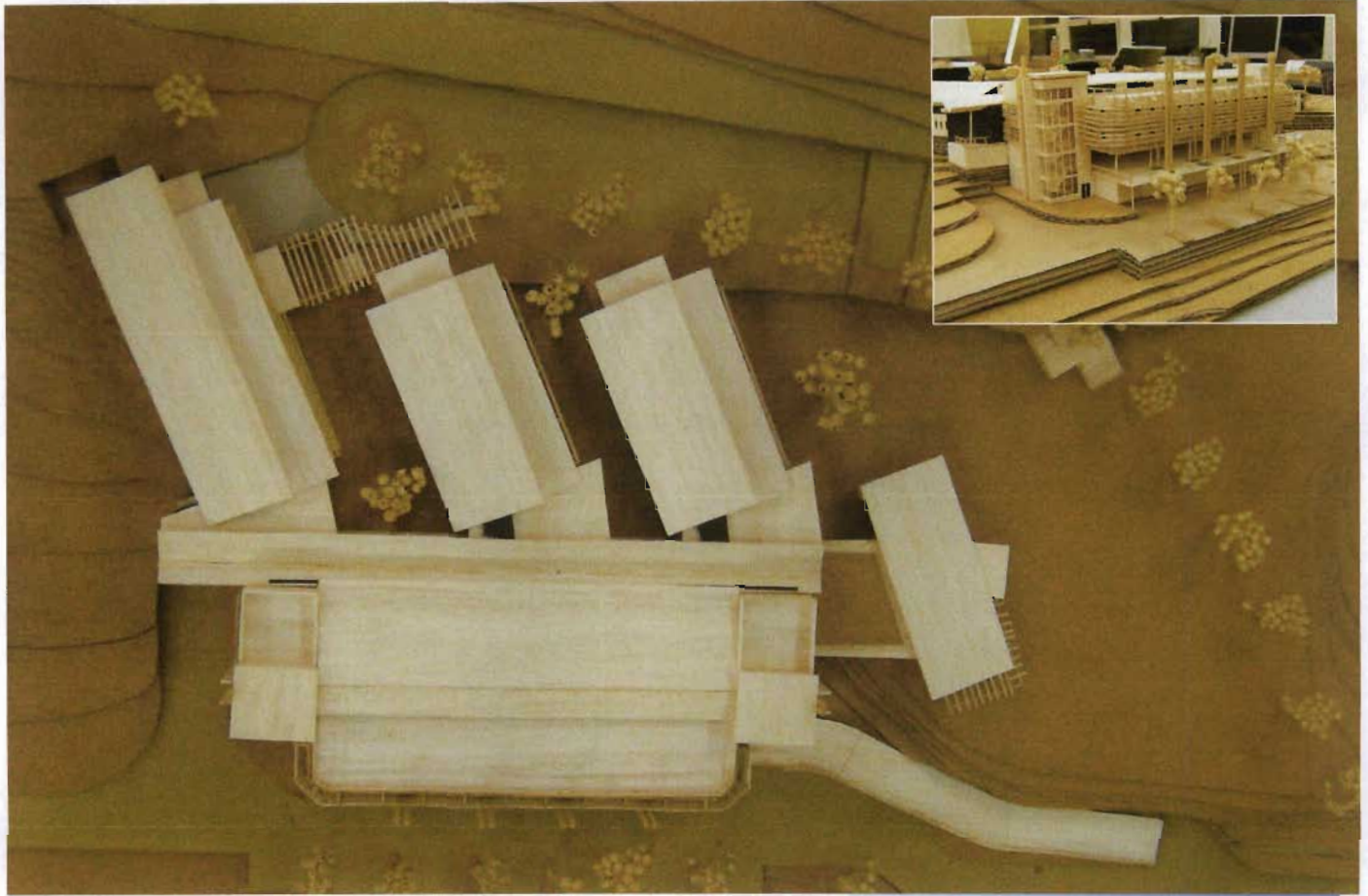
#### Physical Planning

- Do you think that spaces are appropriately placed?
- Are the overall sizes of spaces adequate? Does the 'module' size work?
- How do you find the access in the building?



Appendix D – Photographs of physical model



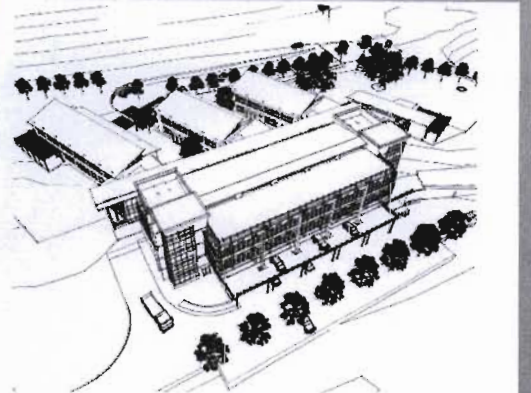
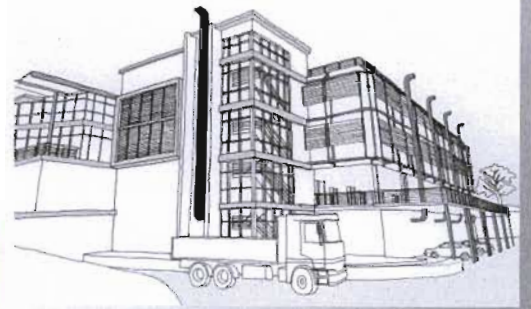
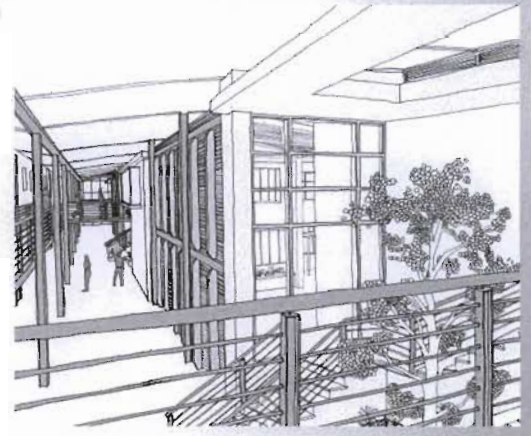
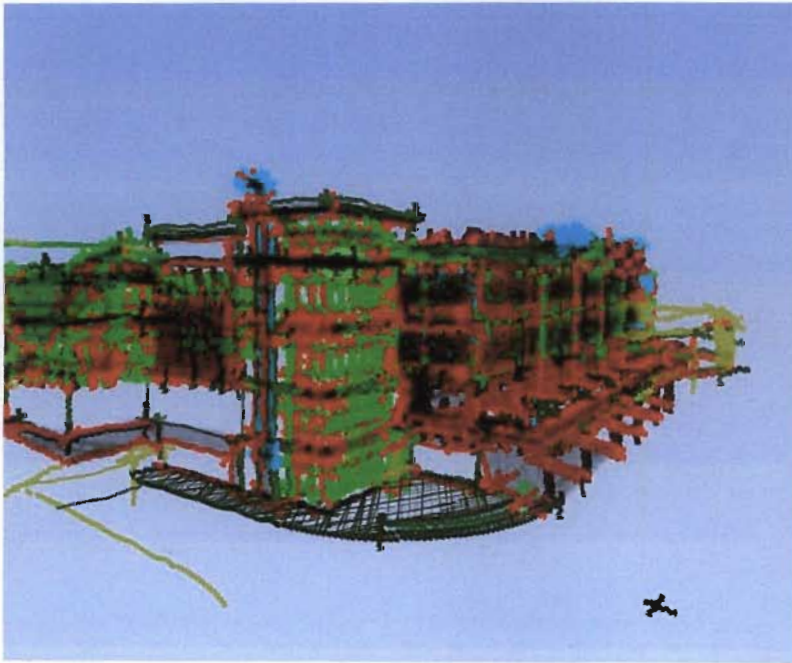


near Research Institute and Laboratories

**Design Dissertation 2008**

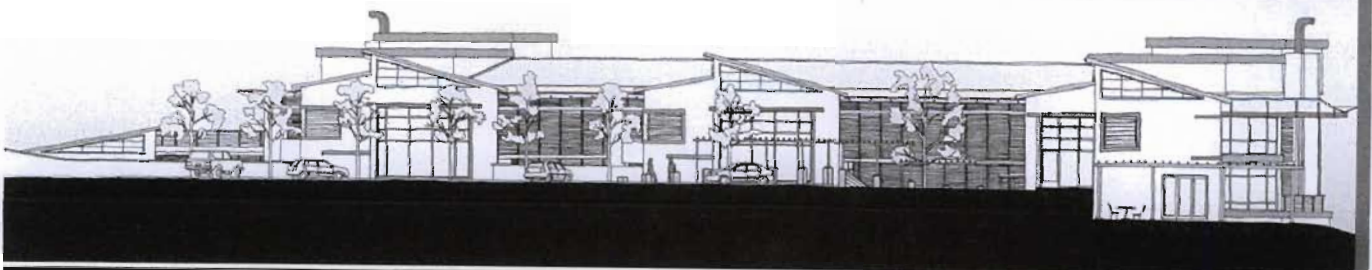
**Design Report**

New Cancer Research Institute and Laboratories



Louis Stephen du Plessis

Student number: 202518387



---

## **Contents**

<b>Introduction .....</b>	<b>1</b>
<b>Site selection .....</b>	<b>2</b>
General .....	2
Site 1 – Ridge precinct.....	3
Site 2 – King Edward VIII hospital precinct.....	4
Site 3- Howard College .....	5
Site 4 – Albert Luthuli Hospital.....	6
<b>Site analysis .....</b>	<b>8</b>
<b>Urban intervention .....</b>	<b>10</b>
<b>Functions of the building.....</b>	<b>11</b>
<b>Client and brief.....</b>	<b>12</b>
<b>Design concepts .....</b>	<b>14</b>
The Internal street with 'book-ends' .....	14
Circulation as form generator .....	14
Clustering of activities .....	15
Relocation of function .....	15
Reduction of servicing .....	15
Decentralisation of services .....	15
<b>Environmental response strategies .....</b>	<b>16</b>
Building form.....	16
Shading, illumination and insulation.....	16
Decentralisation of services .....	17
Maximising resources.....	17
<b>Services strategy.....</b>	<b>18</b>
<b>Structure .....</b>	<b>19</b>
<b>Bibliography .....</b>	<b>20</b>
<b>Appendix A - Design Drawings.....</b>	<b>21</b>

---

## Introduction

The design of the new Cancer Research Institute and Laboratories sets about to create an environment that primarily facilitates the users in the process of research. This is achieved by providing an overall environment that balances the fact that research is increasingly seen as a 'social phenomenon' in addition to an appropriately and well serviced functional environment. Though the laboratory environment is highly serviced and has numerous functional requirements, the design needs to take cognizance of the fact that the laboratory is merely the place in which ideas are tested. Ideas are conceived when both formal and informal inter- and multi-disciplinary interaction takes place (Seitter: 2007), and this interaction has a positive impact on individual research projects, and results in advances. (Kisbey-Green: 2007, Watch: 2007, n.p.) Walljasper (2006), in turn, identifies a "dawning realization" that the creative atmosphere is enhanced by creating better places for interaction.

(ill. 1)

What is therefore established is the need for the design to promote the formal and informal inter- and multi-disciplinary interaction, and this implies that the building has a public realm conducive to this interaction. To achieve a design that strengthens this 'public sphere', Aldo van Eyck argues that spaces should be anchored to the 'public sphere' by having them open onto a larger interior street (ill. 2) and thereby encourage the individual to interact in the public domain. (van Eyck: 1999, 89)

The notion of the use of an internal street as a realm for interaction is taken and developed in the design in addition to responding to the numerous practical requirements, such as structure, planning, servicing and so forth. Notable aspects will be highlighted in this report.



*Illustration 1: Staff at a medical centre interacting with one another at one of numerous coffee bars located around the facility*

*Source: (Griffin: 2000, plate26)*



*Illustration 2: A view of the internal street in the British Airways HQ offices. Cafeteria seating and vertical circulation open onto the street.*

*Source: (Davey: 1998, 40)*

---

## Site selection

### General

In conducting research for the dissertation document, the following aspects were revealed that need to be taken into account when selecting a site as they have an impact on the functioning of the Institute.

According to Watch (2007, n.p.), they are:

- Proximity to a research university;
- The availability of a highly educated workforce;
- Quality of life of the nearest city;
- Proximity to a major airport; and
- Ability to expand at the same site.

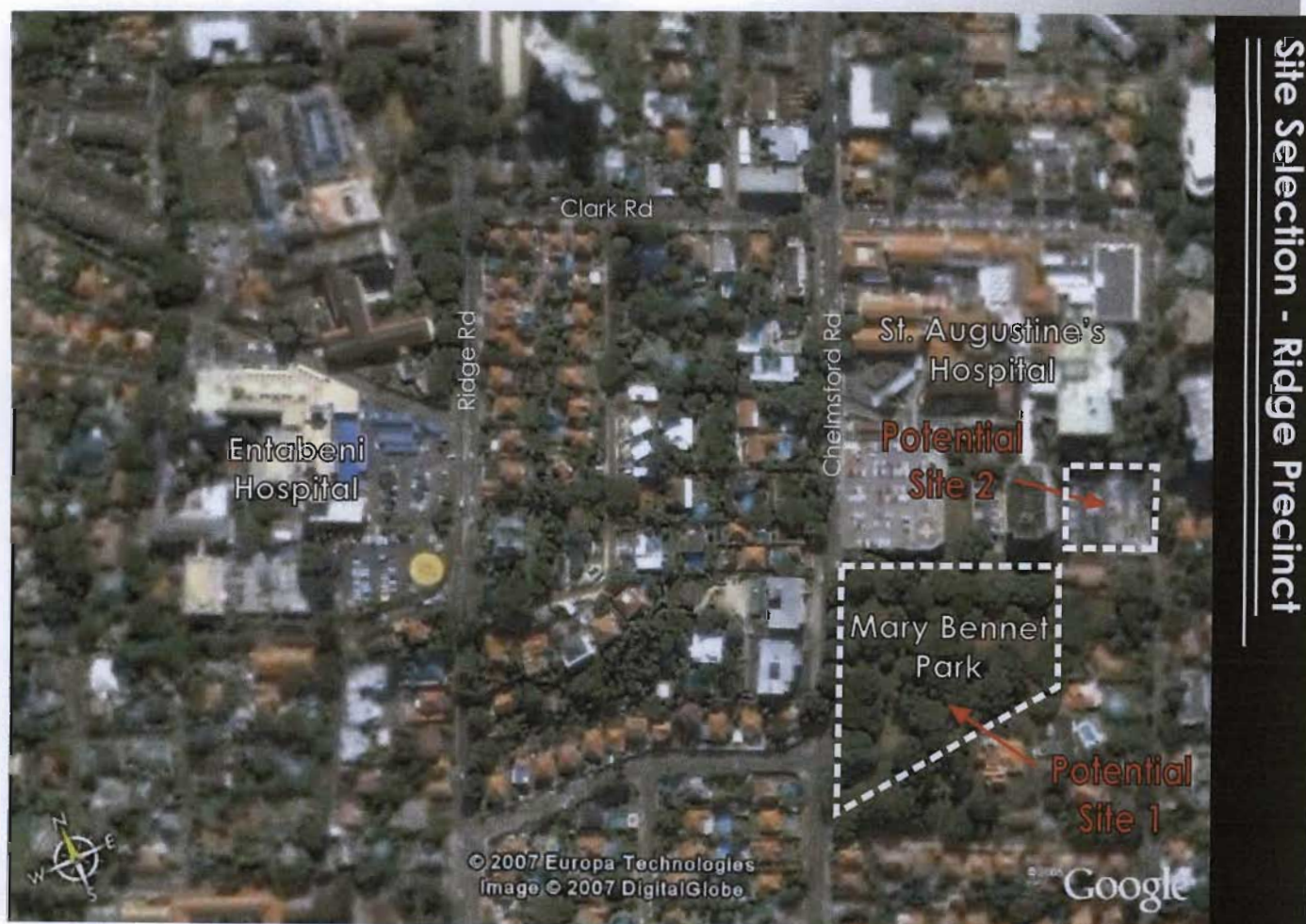
In addition to these aspects, Putnam Gould (1986, 50 - 51) lists:

- Access to utilities as the building is a heavy consumer of power and water, and has specific waste disposal requirements.
- Consideration of the surrounding environment as noise, dust and vibrations may be detrimental to the building functions.
- The immediate and surrounding environment should be pleasant (with views, landscaping etc.) to be a positive factor in recruitment of personnel.

These aspects immediately imply the most suitable location of a facility of this nature is within a major metropolitan area, such as Durban. In the selection of a site that would be most appropriate for the location of the Institute, four possible areas were investigated. These were primarily assessed on existing and potential academic links, the availability of land, the medical framework that existed in the area, the context in which the site was located, the potential availability of test subjects (though subsequently the focus of the Institute changed from clinical to basic research and the availability of test subjects was not a primary concern), and the facilities in the immediate area into which the Institute could link.

### Site 1 – Ridge precinct

This area allowed for the potential to link into the infrastructure of two hospitals within a dense urban fabric. In comparison though, the potential catchment area of test subjects was more localised as the facilities are private, and therefore many patients are based regionally as patients are referred to their local private hospitals if they can afford private healthcare. In addition, these facilities are overwhelmingly clinical treatment based rather than inclusive of an academic approach. Both hospitals also have significantly less departments in comparison to Albert Luthuli Hospital. With multi-disciplinary interaction seen as an important component, this suggests that this interaction would be more limited if locating the Institute at this site.

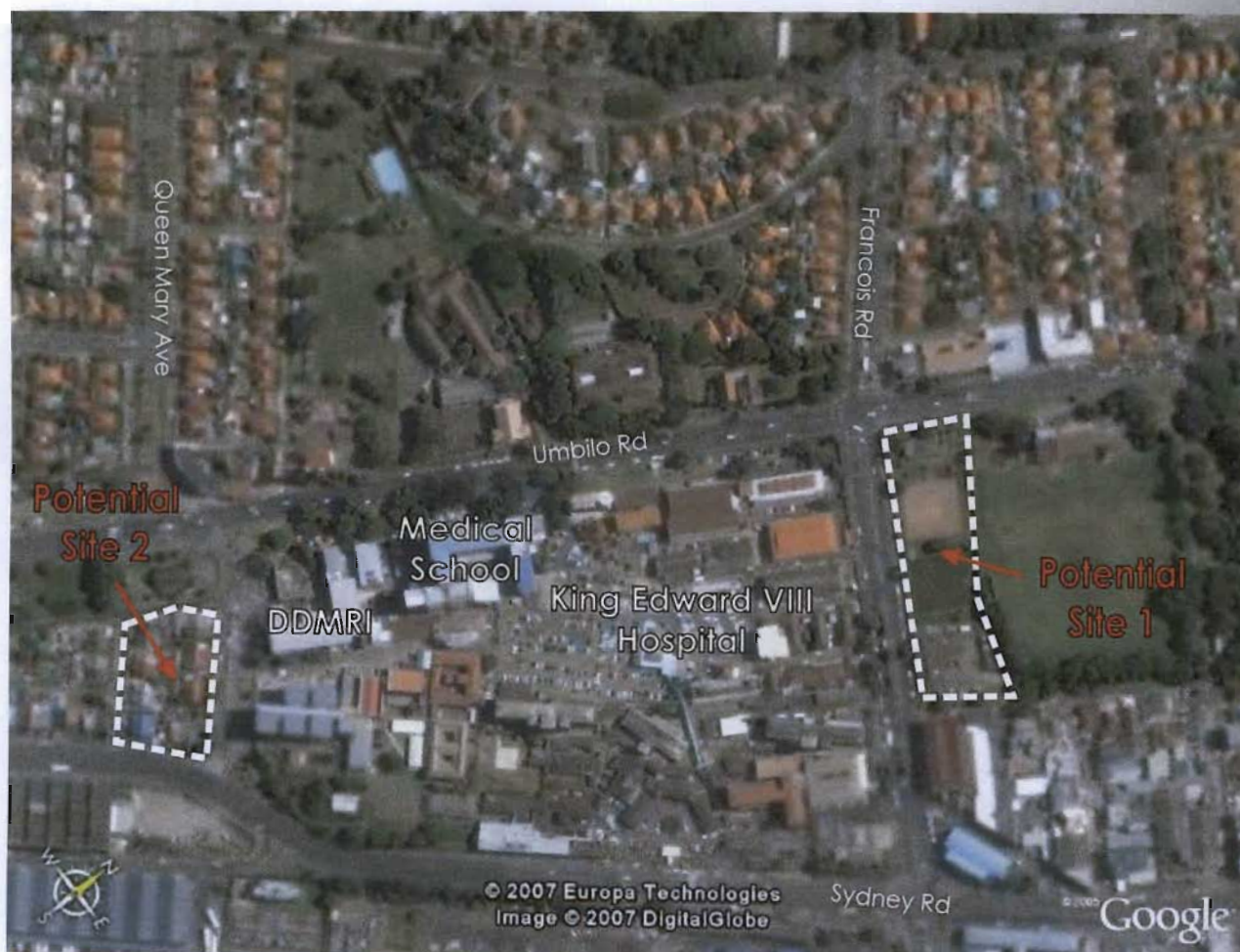


Site Selection - Ridge Precinct

Illustration 3: An aerial photo depicting potential sites close to St. Augustine's Hospital for the location of the Institute. In addition to the reason listed above, site 1 was also not ideal as it would have been encroaching on public open space. Original image: Google Earth

### **Site 2 – King Edward VIII hospital precinct**

The overwhelming benefit of this precinct is the potential to tie into the University of KwaZulu-Natal School of Medicine, allowing for the Institute to benefit from academic links. Two major factors work against the site. Being in a dense urban area, available land for construction is severely limited. King George VIII Hospital is also a regional hospital with limited departments in comparison to provincial hospitals in the public sector.



Site Selection - King Edward VIII

Illustration 4: An aerial photo depicting potential sites adjacent to King Edward VIII Hospital for the location of the Institute. The sprawling campus of the hospital has minimal space left for new developments.  
Original image: Google Earth



### Site 3- Howard College

This area allowed for the Institute to link into the extensive facilities that the university provides. The major drawback is that medical departments are primarily not located on this campus.



Site Selection - Howard College

Illustration 5: An aerial photo depicting potential sites for the location of the Institute. Potential site 2 is located on UKZN grounds. This location allowed for easy interaction with other research institutes in the immediate facility, but none medically focussed

Original image: Google Earth

#### Site 4 – Albert Luthuli Hospital

Albert Luthuli is one of the newest central hospitals in South Africa. It serves as a referral hospital for the entire KwaZulu-Natal province and parts of the Eastern Cape province. It boasts some of the most advanced equipment, skilled specialists and extensive range of departments in the public health sector. The hospital has established academic links as it hosts existing postgraduate research programs from the UKZN medical school. In terms of facilities to do with cancer, it has large, well resourced and modern oncology and nuclear medicine departments.



Site Selection - Albert Luthuli Hospital

Illustration 6: An aerial photo depicting potential sites on the grounds of the Inkhosi Albert Luthuli Central Hospital for the location of the Institute. The topography has a steep slope in most places, and the main hospital building was built using extensive cut and fill.

Original image: Google Earth

After a process of weighting and ranking elements of site selection, Albert Luthuli Hospital was selected for the location of the Institute.

	Ridge Precinct	King Edward VIII	Howard College	Albert Luthuli CH	Precinct Overview
<b>Academic Linkages</b>	Mainly Clinicians <b>3</b>	Medical School proximity <b>1</b>	Related disciplines - non medical <b>4</b>	Post Grad med students & shared departments <b>2</b>	
<b>Land Availability</b>	Park - not ideal Parking - reclamation of lost space <b>2</b>	Limited on site Quite dense area surrounding <b>4</b>	Limited on site Open space designated <b>3</b>	Ample <b>1</b>	
<b>Medical Framework</b>	Catchment area. 2 Hospitals in close proximity <b>2</b>	Regional Hospital - referral to IALCH <b>3</b>	Not conducive to medical research <b>4</b>	Research and specialized treatment established <b>1</b>	
<b>Context</b>	The bottom line <b>2</b>	Duplication of function - DDMRI <b>3</b>	Med school res. related disciplines otherwise nothing <b>4</b>	Plug into plans for proposed relocation <b>1</b>	
<b>Test Subjects</b>	Mainly treatment oriented <b>2</b>	Mainly treatment oriented <b>2</b>	Purpose visit <b>4</b>	Referral based, large catchment - great opportunity <b>1</b>	
<b>Facilities</b> Though independent	Entabeni - 28 disp St. Augst - 24 disp <b>2</b>	15 disciplines <b>3</b>	Limited - biology department <b>4</b>	KZN Lab services 48 disciplines Ultra modern - PPP <b>1</b>	
<b>Overall Ranking</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>1</b>	

Illustration 7: A table of ranking sites per category to determine the site of the Institute. Albert Luthuli received the highest ranking.

**Site analysis**

The analysis of the two sites primarily consisted of topography, noise, visibility and the existing urban framework. Of the two sites located at Albert Luthuli, the first potential site was quickly deemed unsuitable due to the excessively steep topography that characterises the precinct. The second site, though still moderately steeply sloped, offered the most potential without having to resort to extensive earthworks.



Illustration 8: An aerial view of the greater Durban area indicating major routes and the location of the site.  
Original image: Google Earth

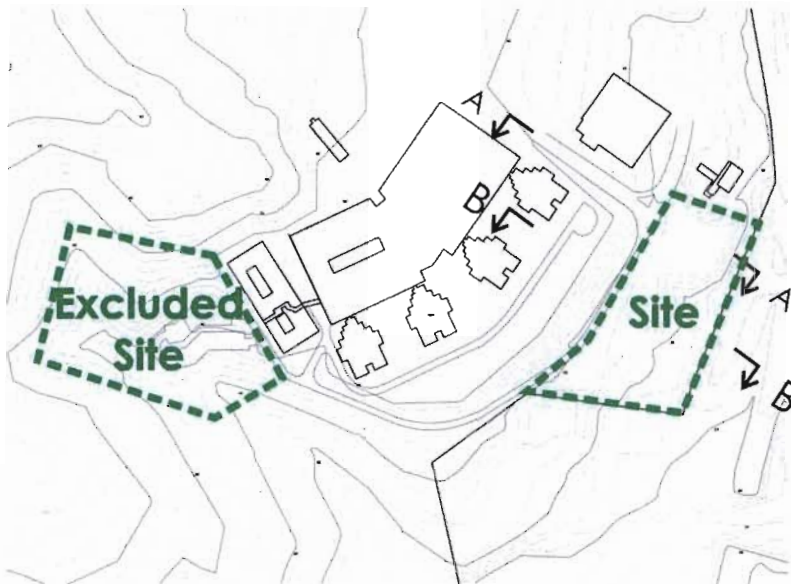


Illustration 9 (left): Site map indicating 2m contours. The existing hospital buildings were constructed on extensive cut and fill levels. The selected site has a more manageable slope than areas surrounding it.

In addition to this, its location on the major road boundary offered the potential for the facility to be visible to passing commuters, thereby reinforcing the important work being conducted therein.

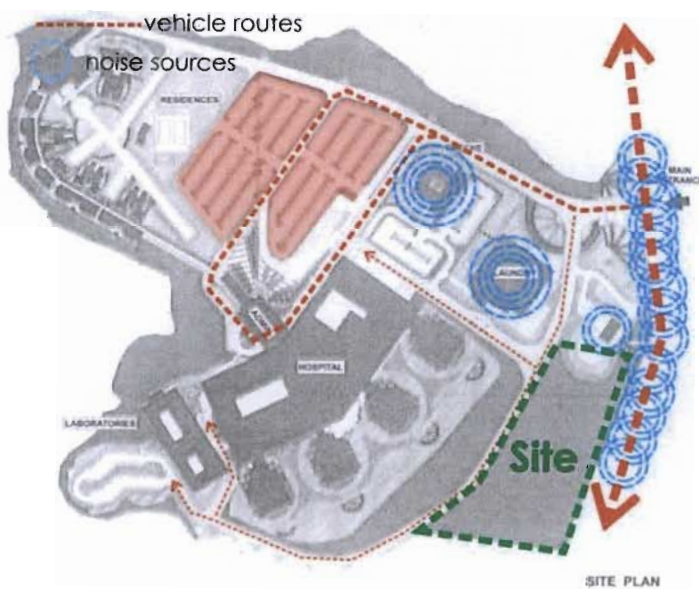


Illustration 10 (left): Site map indicating noise sources and vehicle routes. Bellair road runs parallel to the east edge of the site, and the two are separated by a strip of open space.  
Original image: FGG architects

The site analysis also revealed that large numbers of staff were leaving the hospital property to spend their tea and lunch breaks at the Cato Manor soccer grounds, located across the road. This indicates that there is a lack of open space with sufficient amenities that staff can use during their breaks on the hospital property.

Climatic factors were also taken into account in the site analysis. The slope faces an easterly direction, which is impacted by morning sun and the prevailing winds during the day.

Illustration 11 (below): Aerial photo and images of immediate surrounds to the site.

Clockwise from left: Boiler building, main entrance, Cato Manor soccer fields with main hospital building in background, and strip of open land that separates the site from Bellair Rd.

Source of aerial photo: [www.durban.gov.za](http://www.durban.gov.za)



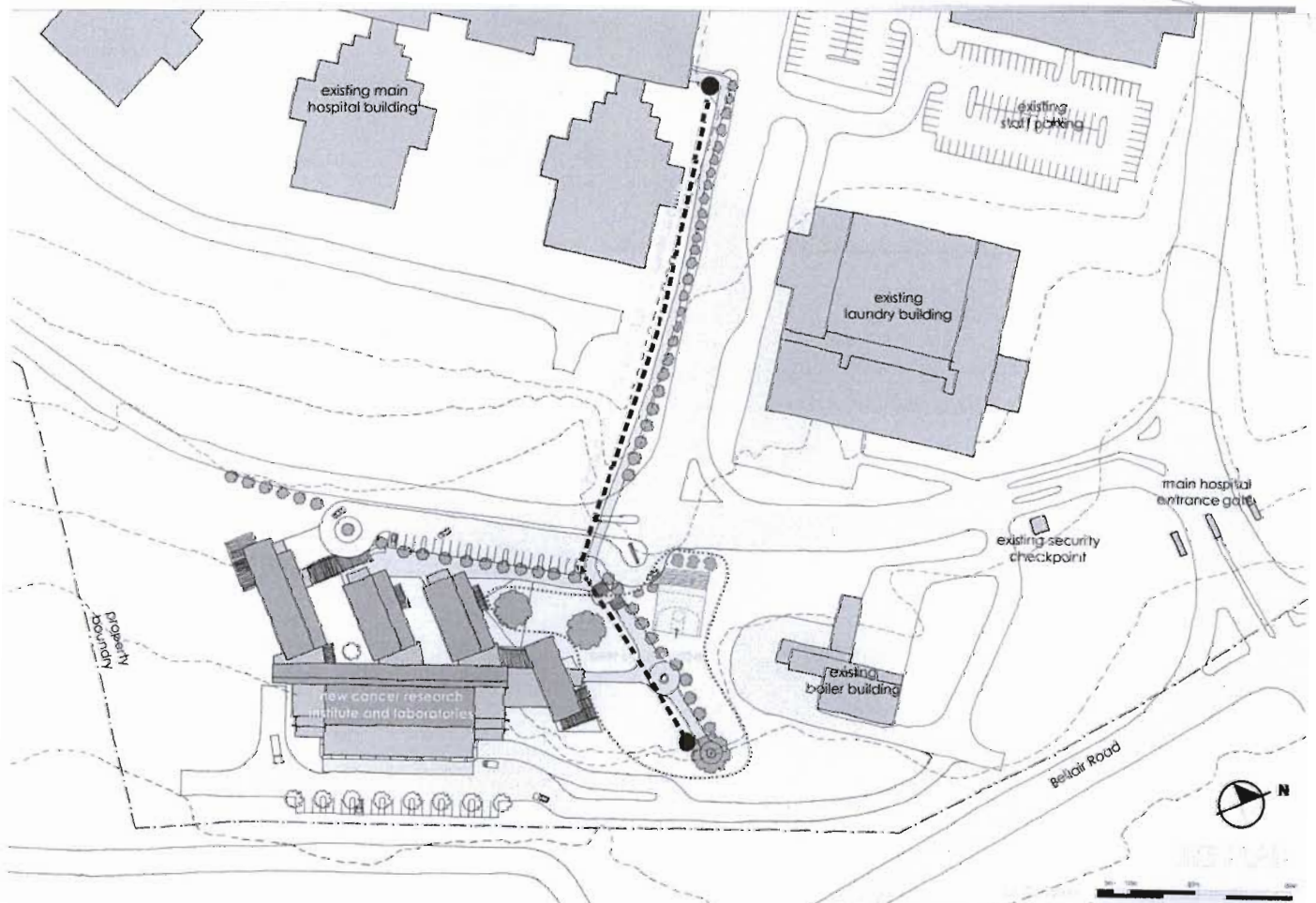
## Urban intervention

As noted from the site analysis, the design addresses the distinctive lack of open space for staff. The topography of the site had a relatively flat area towards the north of the site, adjacent to the route that most of the staff would take on their way to the sports field. This provided the opportunity for the inclusion of an open space within the design to cater for this need. The intervention is not extensive, but merely provides an open area with a few amenities, such as seating, shade, drinking water, refuge bins, and flat paved surface for two-on-two basketball or other physical activity. The open space also links into the Institutes' cafeteria, allowing the opportunity for hospital staff to make use of this facility and thereby assisting in multi-disciplinary interaction.

*Illustration 13 (left): Sketch of open space depicting further amenities to be provided for Institute and main hospital staff. Lighting, seating, shade, drinking fountains and dustbins are included.*



*Illustration 12 (above): Sketch of open space walkway with basketball hoop in far right of image and stairs leading to path that links to main hospital building.*



*Illustration 14: A site map depicting the open space in relation to the institute and the formalisation and extension of the existing pedestrian route by staff that currently use the Cato Manor soccer fields during their breaks.*

## **Functions of the building**

Basic research into cancer will be conducted in the Institute. Researchers will study how cancer cells work in order to understand what makes cancer cells different, thereby allowing for further treatments and diagnoses to be developed. Therefore, the Institute will consist of research facilities such as laboratories and their support functions, researcher's and administration staff offices, a library, and seminar rooms. As the facility will be involved in basic research, no clinical research will be conducted, therefore the users will be staff, visiting professionals collaborating with staff, or attending the occasional seminar and limited personal visitors of the staff. The facility is not open to the general public. General Hospital staff will have access to the cafeteria, but as the Institute is located within a restricted area of the property, general members of the public will not have any access.



*Illustration 15: Scientists engaged in cancer research.*

*Source: (Cancer Research UK: 2004, n.p.)*

## Client and brief

The client for the design is the National Health Laboratory Services of South Africa (NHLS). It is a government institution involved in research, diagnostic laboratory services, teaching and training amongst other activities across South Africa.

As a major role-player in the public health care sector, the NHLS has the following objectives:

- To provide a world-class health laboratory service through competent, qualified professionals and state-of-the-art technology, supported by academic and internationally recognised research, training and product development.
- To conduct research appropriate to the needs of the broader population, which include cancer research.
- To make major contributions to national and international medicine

In light of the Client's objectives, the cancer research institute is to conform to international standards in planning and servicing and create a pleasant environment that attracts and retains a high calibre of staff to conduct the research and facilitates the research process.

The staff component will comprise of 90 to 120 people, and the accommodation to cater for the staff is as follows:

Schedule of accommodation - Cancer Research Institute and Laboratories

	Space	Quantity	Size	Total area	Space description
Laboratory Component	Laboratories	10	150	1500	Space where physical research processes are conducted. The space is partitioned and
	Lab wash up	4	15	60	Used equipment, such as glassware, is removed here to be cleaned and sterilised.
	cleaner depot	4	12	48	General cleaning equipment and supplies are stored here.
	Locker room	4	15	60	Researcher's personal belongings and personal protection equipment (PPE) are stored here.
Research Offices	open plan	150	300	2	Junior researchers involved in team research have desks in the open plan area.
	senior researcher	20	160	8	Cellularised offices for leaders of research groups.
	private offices break-away / discussion spaces	15	210	14	General members of research groups occupy some offices, others are temporarily used when audio and visual privacy is required.
		25	100	4	Small social spaces which double as informal discussion areas for smaller groups.
Servicing	Mechanical plant rooms	1	550	550	Rooms where the plants required to service the laboratories are housed.
	Central stores	1	60	60	Storage space for bulk laboratory consumables delivered.
	External Gas storage	1	20	20	Undercover storage area open directly outdoors where cylinders supplying gas to the laboratories are housed.
	Computer server room	1	15	15	Hardware for the facility's computer network is housed here.
	Emergency generator room	1	15	15	Equipment, such as the Uninterrupted power supply batteries and the back-up generator are housed here.
	Hazardous Waste Storage	1	30	30	Waste generated in the laboratory is temporarily stored here to be removed for disposal by an outside contractor.
Administration	open plan	1	120	120	Administration clerks have desks in this area.
	senior administration staff	2	20	40	Individual cellular offices for senior administration staff.
	private offices break-away / discussion spaces	6	15	90	Certain administration staff occupy some offices, others are temporarily used when audio and visual privacy is required.
		2	25	50	Small social spaces which double as informal discussion areas for smaller groups.
	file storage	1	20	20	Fireproof storage areas for files and data
	reception / waiting	1	40	40	Visitors to the facility enter here and report to the reception desk and wait to be escorted around or the member of staff they are visiting meets them there.



	Space	Quantity	Size	Total area	Space description
Social Amenities	Conference	2	70	140	Hosts larger staff meetings and conferences with external professionals.
	Library	1	90	90	A reference library housing predominantly periodicals and journals. Staff and visitors can come to sit and read.
	Central social space	1	250	250	This space functions predominantly as the seating space of the cafeteria.
	Kitchen	1	50	50	Food is initially stored and then prepared for serving in the cafeteria.
	Yard Space	1	36	36	Temporarily holds kitchen waste to be removed and disposed of.
<b>Total</b>				<b>3312</b>	Total area excludes circulation, ablutions and area of undercover parking.

Ablutions	Males	WC	5	As per NBR requirement for a population of up to 180.
		Urinals	11	
		WHB	8	
	Females	WC	16	
		WHB	8	
	Universal Access	WC	3	
	WHB	3		

Parking	75 Staff	Due to the high floor area to staff ratio, local council requirements of 4 bays per 100m <sup>2</sup> for the class of building will result in an over-supply of parking. The calculation for required parking has therefore being restricted to occupied areas.
	20 Visitors	

**Design concepts**

**The Internal street with 'book-ends'**

As researching has been recognised as a 'social phenomenon', the internal street onto which spaces open is a primary planning element. This element reinforces the public realm by having more individuals having to use the space as they go about their activities. In addition to this, communal functions are located at either end of the street to encourage movement along the entire length of the street. By grouping communal functions at one end, the other becomes less used and reduces potential interaction between individuals.

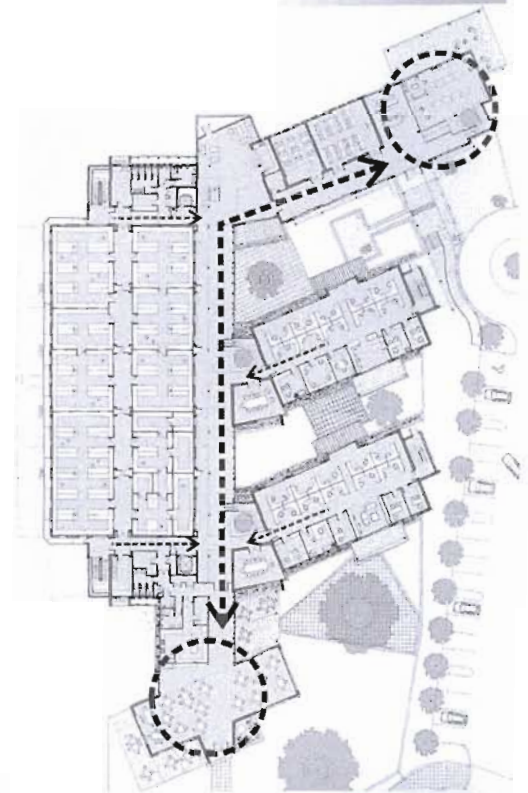
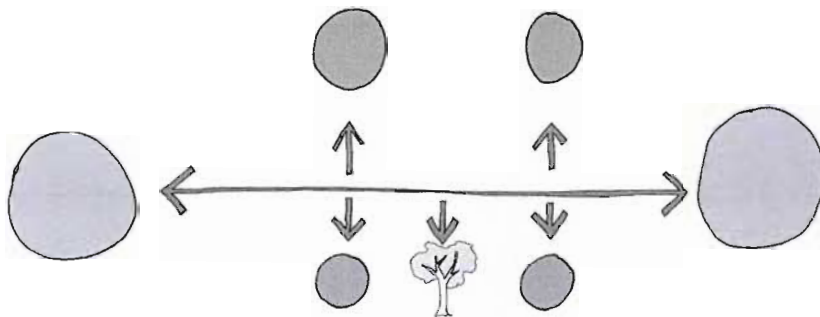


Illustration 16 (left) and 17 (above): Diagrams indicating the principle of the internal street with spaces opening out onto it and communal functions at either ends, and the translation thereof in the design.

**Circulation as form generator**

Implied in the internal street is the process of circulation. In this design, a clear circulation pattern was applied. This not only assisted in the important aspect of making the building more legible, but also assisted in the more practical aspect of ensuring that the requirements of fire escape routes were adhered to.

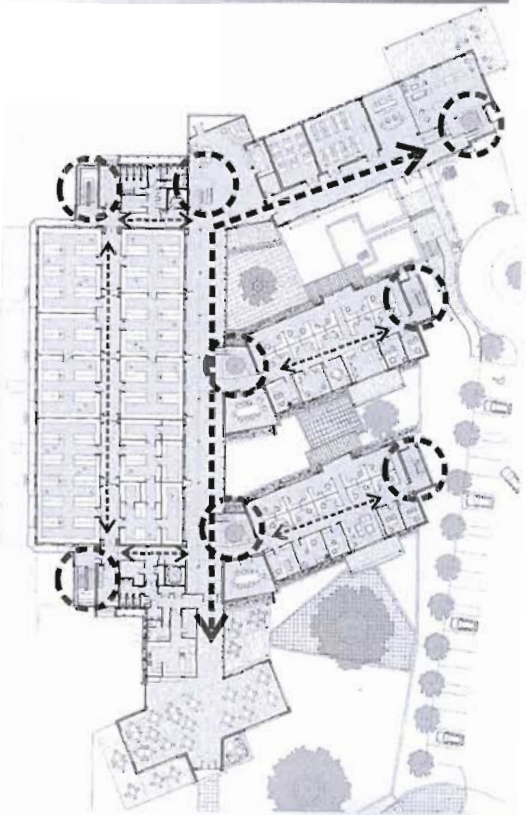
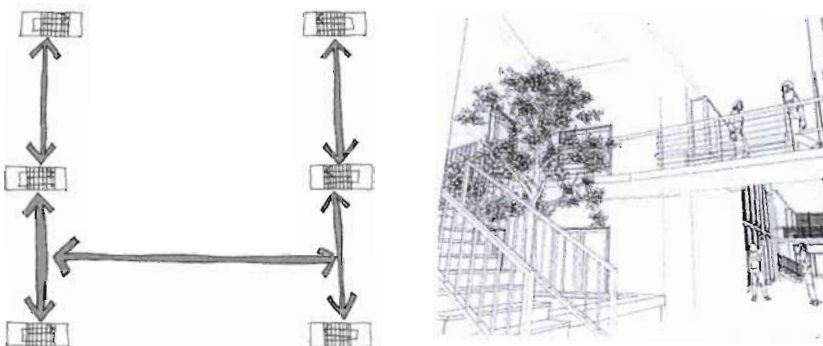


Illustration 18 (left), 19 (centre) and 20 (right): Diagram indicating the principle of stairs and circulation being a planning generator, a sketch showing a stairway along the internal street, and a diagram indicating the design response to the principle.

### **Clustering of activities**

To strengthen the 'public realm' of the Institute, certain activities are clustered together to increase the overall use of the region and facilitate interaction. For example, the reception area, which is usually a quiet area removed from the normal happenings of the Institute, is clustered together with the library. The users of the library now have an opportunity to interact with individuals more frequently and the library acts as a larger waiting area for visitors at reception.

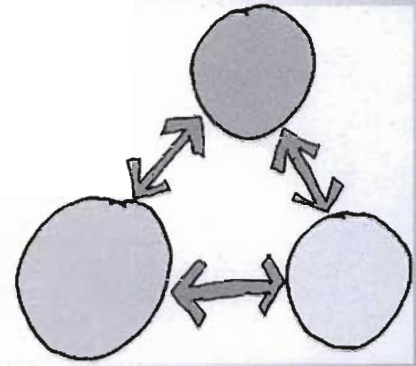


Illustration 21: Diagram indicating the principle of clustering activities together. Individuals participating in one activity have an opportunity to interact with individuals participating in another.

### **Relocation of function**

Traditionally, certain activities have taken place within certain zones. In the attempt to reduce the area posing a high risk and utilising high energy, a current trend is to remove these functions to a more suited location. Laboratory write up spaces used to be included adjacent to the laboratory work bench, but are now located separately. In addition, more noxious experiments are restricted to fume cupboards, thereby reducing the overall ventilation requirements.

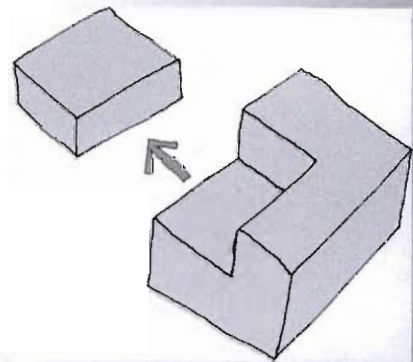


Illustration 22: Diagram indicating the principle of relocating functions to reduce the volume of high energy consumption and risk areas.

### **Flexibility of space and services**

To ensure long term sustainability of the Institute, spaces and services need to be easily reconfigurable to changing laboratory processes. By instituting an internationally recognised module size and a servicing strategy that can be easily modified, this can be achieved.

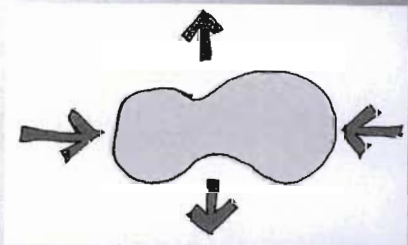


Illustration 23: Diagram indicating the principle of flexibility of space and services, which is key to the long term sustainability of the laboratory program

### **Reduction of servicing**

Due to the high consumption of laboratory processes, significant savings can be made by reducing the servicing requirement. This includes restricting the overall volume of the laboratory space, using ultra-low flow taps and toilets and implementing a computerised building management system.

### **Decentralisation of services**

By including more frequent smaller plants in the facility, overall energy consumption can be reduced and more variants of conditions can be achieved. In addition, should one system fail, the effects are minimised as the entire facility is not dependent on the individual system.

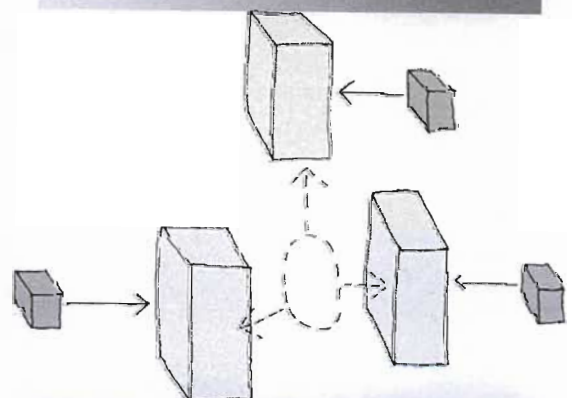


Illustration 23: Diagram indicating the principle of decentralisation of services. Smaller plants located throughout the facility have greater benefits than one large plant

## Environmental response strategies

### Building form

The building form places the internalised, climatically controlled spaces of the laboratories to the east. This allows for the built form to protect the courtyards in addition to buffering the naturally ventilated areas of the offices on the west. Where appropriate, the built form faces due north to optimise solar conditions.

### Shading, illumination and insulation

Where appropriate, solar shading devices have been included in the design in a specific manner to shade from the harshest sun, but still allow winter penetration and the implementation of a light shelf. This allows for the maximisation of natural daylighting within spaces, thus reducing the requirement of artificial lighting. In addition, a system utilising task and ambient lighting has been implemented to reduce artificial lighting requirements overall. This system is linked to automated sensors that can adjust artificial lighting levels in response to the levels of natural lighting levels.

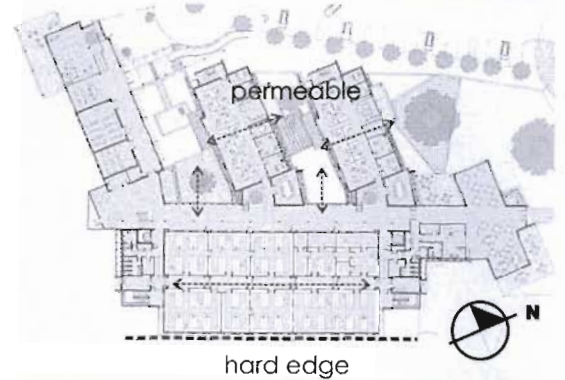
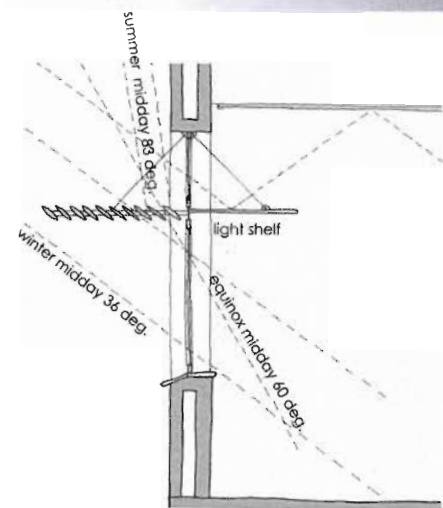


Illustration 24: Diagram indicating the placement of building mass so that the hard edge of the laboratory protects the permeable screened internal street and courtyards.



Controlled usage of natural daylighting

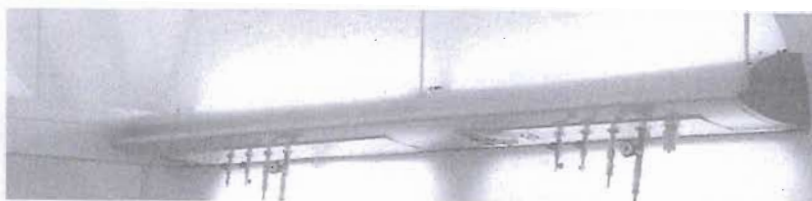
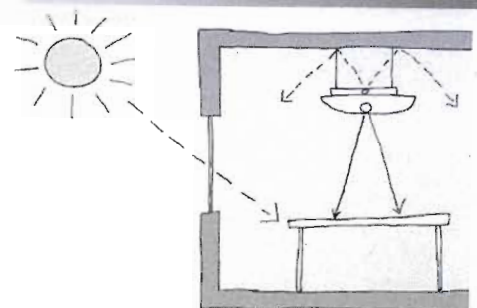


Illustration 26: Image showing the service carrier to be used in the laboratory with integrated task and ambient lighting.  
Source: (Waldner Firmengruppe: n.d., 47)

A cavity wall has been implemented for the exterior skin of the building. Not only does this allow for integration of concrete columns into the wall, but also serves to insulate the interior from temperature extremes and provides a more effective moisture barrier. In addition, all roofs are insulated using 50mm Isoboard.

Illustration 25: Diagram indicating the use of solar shades to permit daylight from the equinox onwards into winter into the building and to allow for reflected daylight to penetrate deeper into the space by utilising a light-shelf.



task and ambient lighting

Illustration 27: Diagram indicating the use of task and ambient lighting of internal environments in conjunction with natural daylighting to reduce the requirement of artificial light.

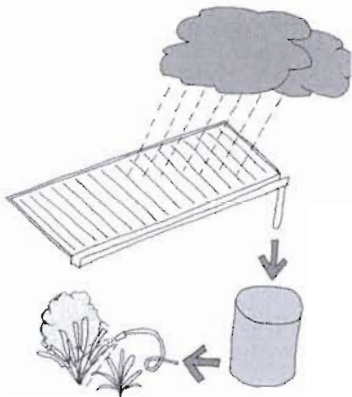
### **Decentralisation of services**

As mentioned before, an approach to decentralising services is taken. By localising plants, energy wasted by transferring processed gases and liquids over longer distances is reduced.

### **Maximising resources**

In order to reduce dependence on municipal services, harvesting of natural resources is implemented where appropriate. Solar water heaters provide hot water for non-laboratory purposes and rain water is collected for irrigation of landscaping at a later stage.

The air handling system, which is a large consumer of energy, includes an energy recovery system. This would most likely be a closed coil system to eliminate contamination of incoming air.



Grey water harvesting



Solar water heating

*Illustration 28: Image showing the harvesting of natural resources. Though the laboratory processes themselves require traditional supplies of resources, non-laboratory consumption can be supplied by naturally harvested means that are augmented by traditional supplies.*

**Services strategy**

The 4 major types of services distribution to the laboratories are: continuous end-wall service corridors, vertical distribution, horizontal distribution, and interstitial floors. The system employed in the facility is horizontal distribution. This model has major service lines that are grouped and run at the ceiling level and tapped off where required. Services in the laboratories themselves are on overhead service carriers hung from the underside of the structural floor system and feature quick connect / disconnect fittings. This system is highly flexible as well as simple. It allows for the ability to group systems horizontally in order to control safety, energy consumption, hours of operation and security. Though it has a higher initial cost for implementation and has a higher floor to floor requirement, it offers the lowest life cycle costs.

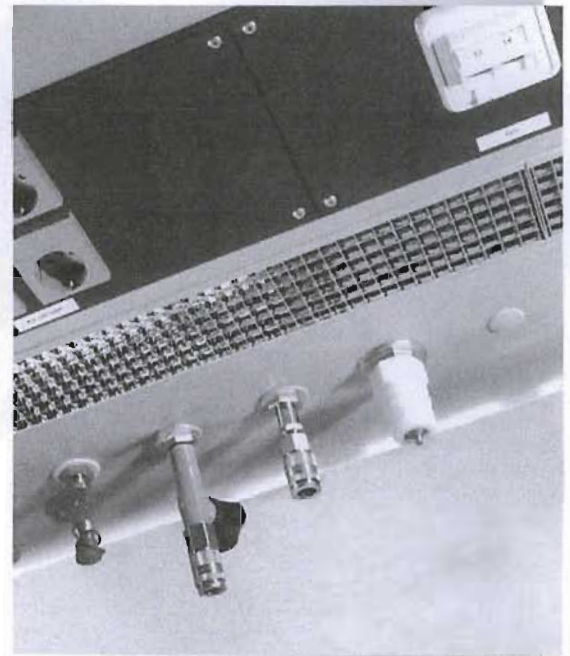


Illustration 29: Image depicting the easy connects to services on the overhead carriers to be used in the laboratory.  
Source: (Waldner Firmengruppe: n.d., 45)

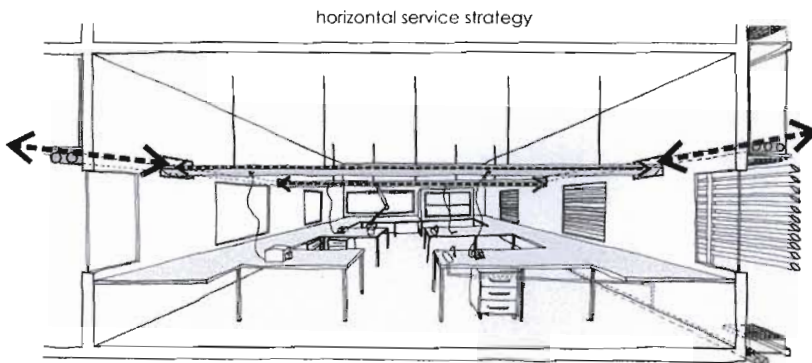


Illustration 30: Diagram indicating the servicing strategy of the building. Main service lines run horizontally along the outside of the laboratory space, either on the exterior frame or along the corridor separating the laboratory spaces. Services are then tapped off perpendicularly along overhead service carriers and drop down where required.

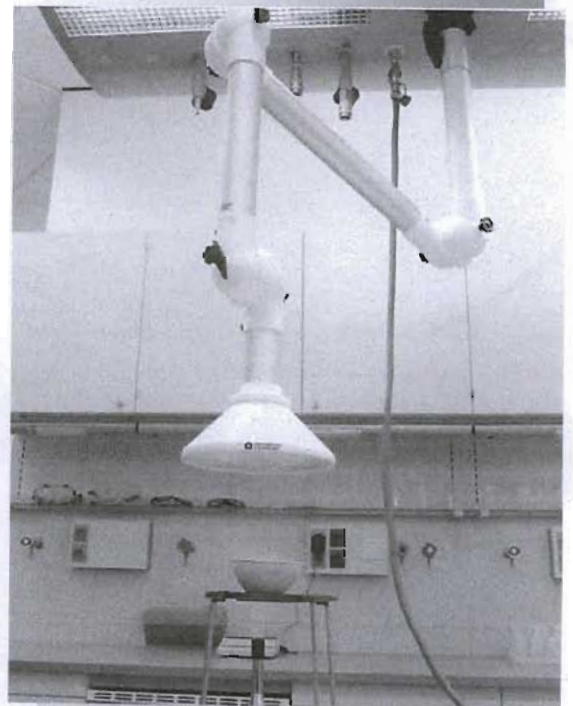
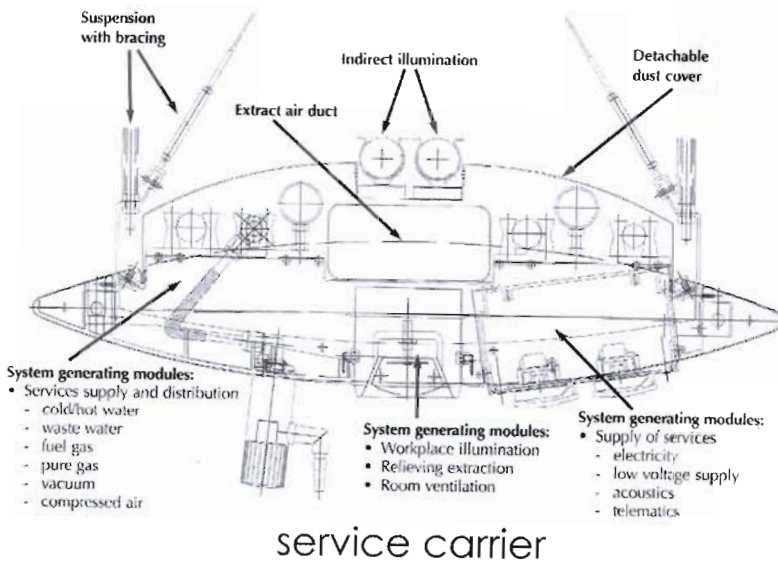
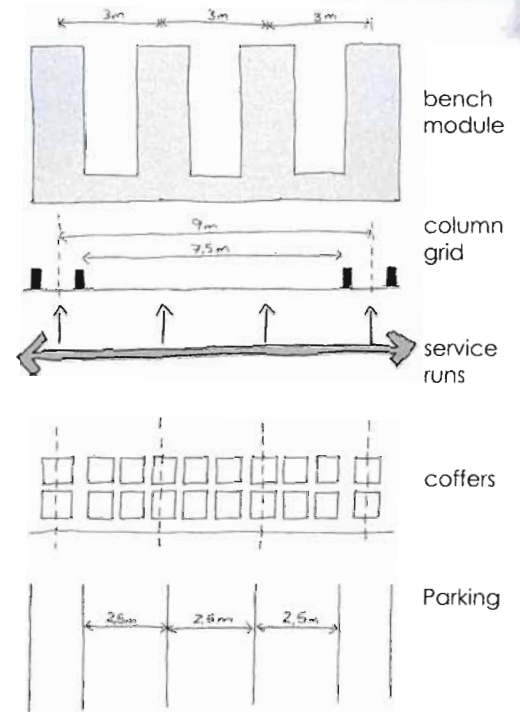


Illustration 31(above): Image depicting the ventilation cowl that can be attached to the service carrier exhaust system to extract at the source of contamination.  
Source: (Waldner Firmengruppe: n.d., 45)

Illustration 32(left): Section through overhead service carrier, which is suspended from the underside of the laboratory ceiling.  
Source: (Waldner Firmengruppe: n.d., 44)

**Structure**

Due to the unusual 1,5m module on which the laboratory space is laid out, certain complexities arise in structural planning. The particular approach taken has a double column grid. This allows for a relatively economical parking layout to be applied. Service branches from main lines are also not interfered with as the columns are offset from the centre line of laboratory benches.



Planning considerations

Illustration 33: Diagram indicating the overall structural planning considerations taken in the design.

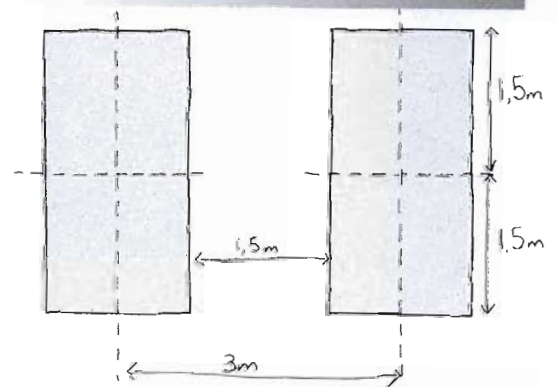


Illustration 34: Diagram indicating the laboratory bench module, the fundamental building block of the laboratory component.



Illustration 35: Diagram indicating some potential divisions within the overall laboratory space. Each module is 3m x 3m.

---

## **Bibliography**

Cancer Research UK (2004)

<http://www.cancerresearchuk.org/> (Accessed 17 July 2007)

Davey, P. (1998) The City in the Wilderness. *Architectural Review*. August 1998, pp 36 – 45.

Griffin, B. (2000) *Laboratory Design Guide*. Oxford: Architectural Press.

Putnam Gould, B. (1986) Laboratory design considerations. In S. Braybrooke (ed.) *Design for Research, Principles of Laboratory Architecture*. New York: Wiley. Pp 49 – 65.

Van Eyck, A. (1999) The Medicine of Reciprocity Tentatively Illustrated. In V. Ligtelijn (ed.) *Aldo van Eyck, Works*. Basel: Birkhäuser. Pp 88 – 89.

Waldner Firmengruppe (n.d.) High-Tech-Schulsystem II – Trade Literature Catalogue. Hamburg: Waldner. Pp 1 – 69.

Walljasper, J. (2006) Big Plans on Campus. *Project for Public Spaces*.

[http://www.pps.org/campuses/info/campuses\\_articles/campus\\_bulletin](http://www.pps.org/campuses/info/campuses_articles/campus_bulletin) (Accessed 14 December 2007)

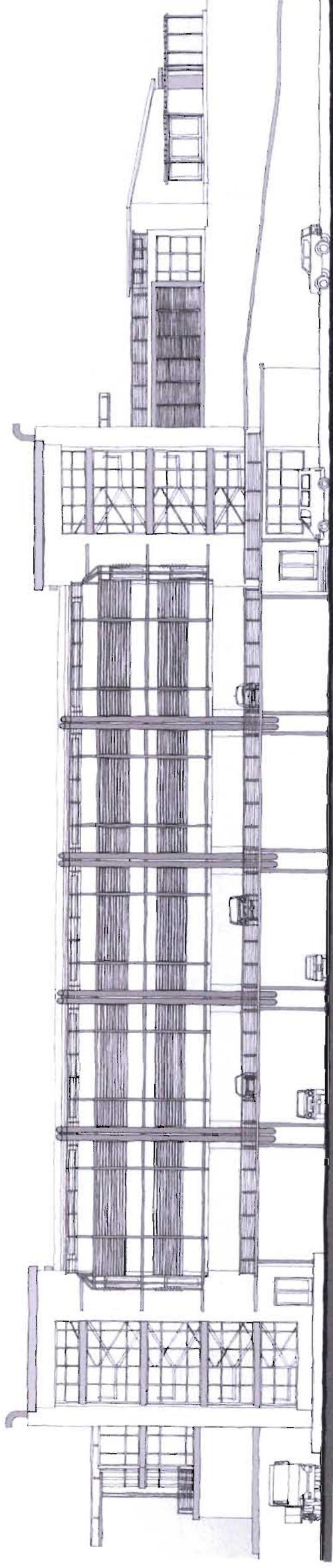
Watch, D., Tolat, D. (2007) *Sustainable Laboratory Design*.

<http://www.wbdg.org/design/sustainablelab.php> (Accessed 17 July 2007)

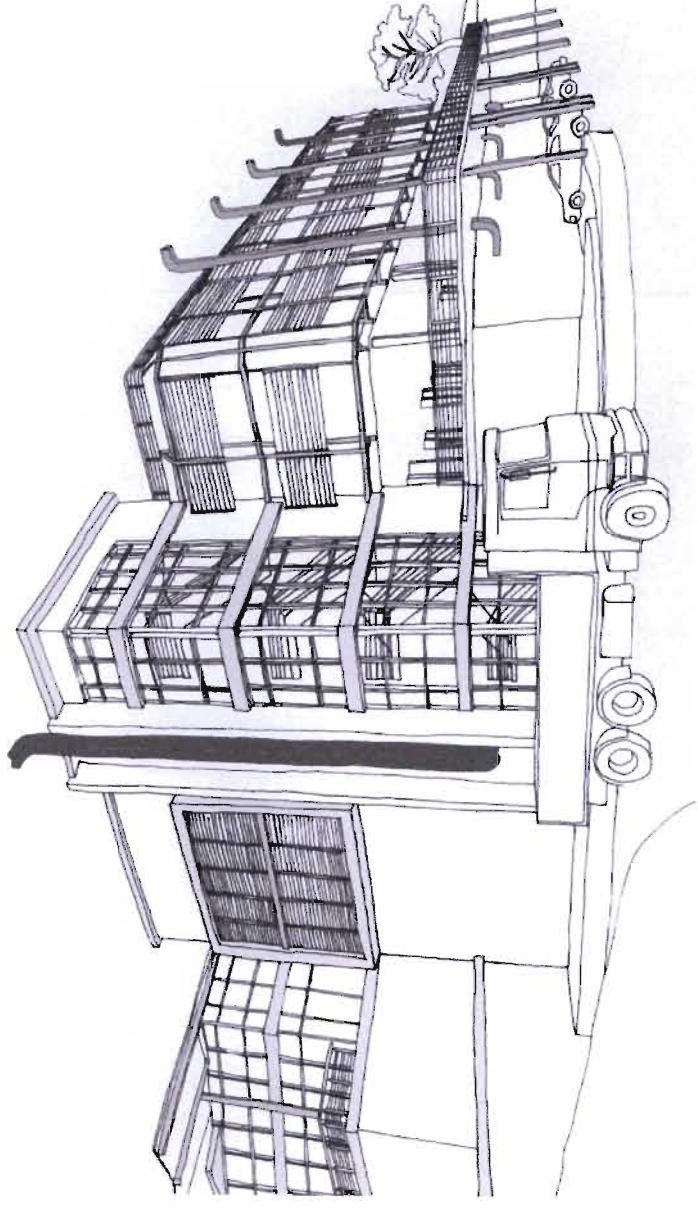
Kisbey-Green, H. (Operations and Administration Manager, Centre for the AIDS Programme of Research in South Africa, Doris Duke Medical Research Institute), 16 March 2007, Durban.

Seitter, G. (Project Architect, Retrofit - Block H Physics and Chemistry Laboratories, UKZN Westville Campus), 17 April 2007, Durban.





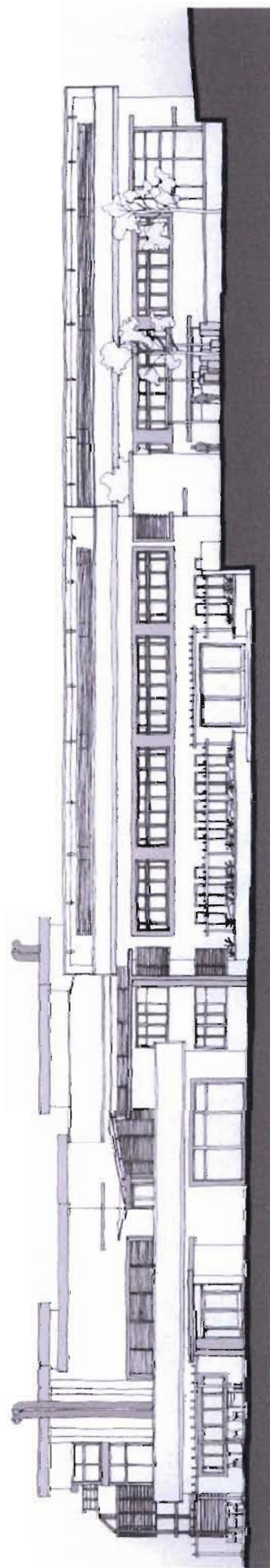
Perspective showing internal street



Perspective showing major street facing facade and corner stairs

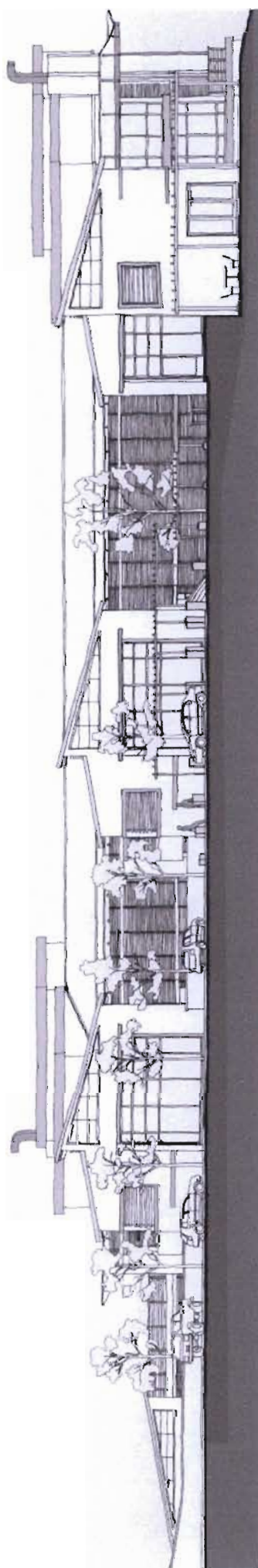


Cancer Research Institute and Laboratories



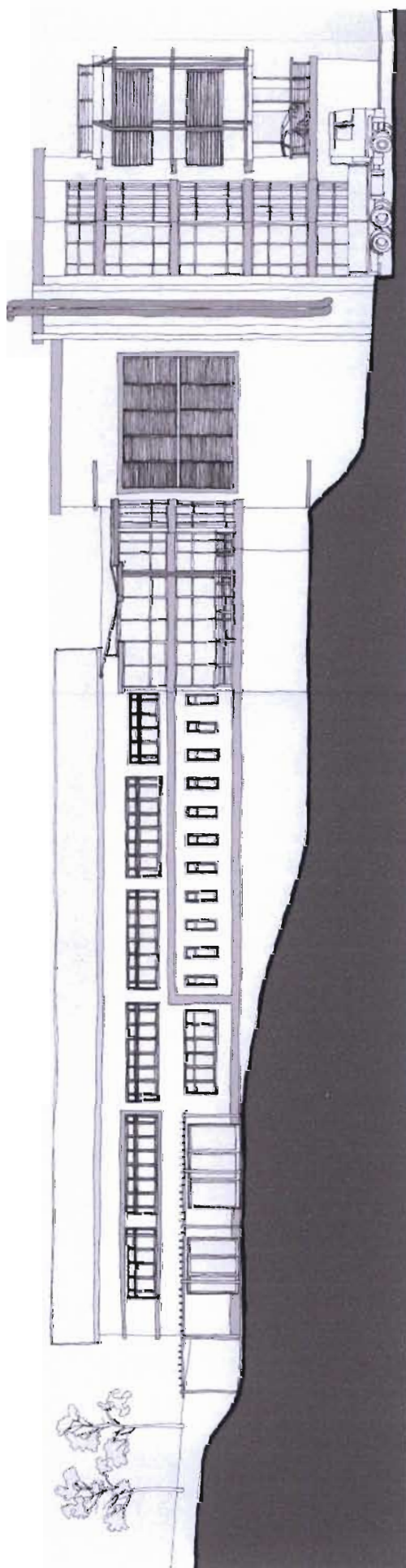
NORTH ELEVATION

Scale 1:100



WEST ELEVATION

Scale 1:100

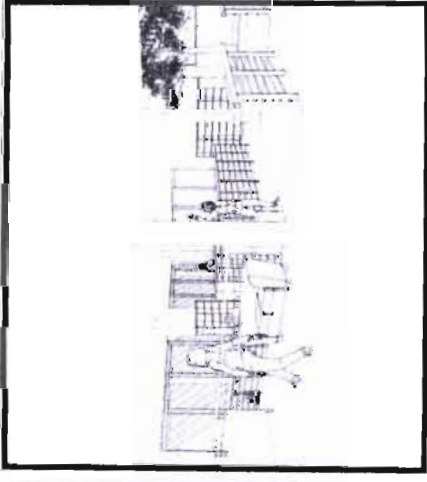


SOUTH ELEVATION

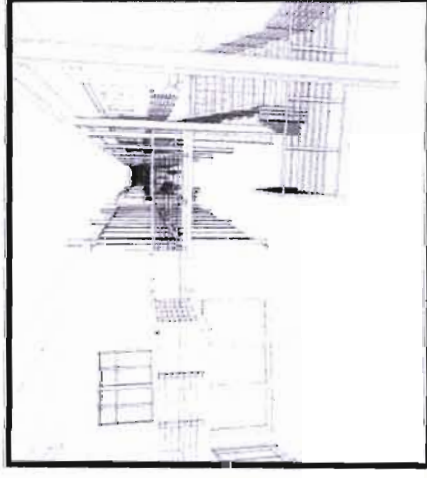
Scale 1:100

Cancer Research Institute and Laboratories

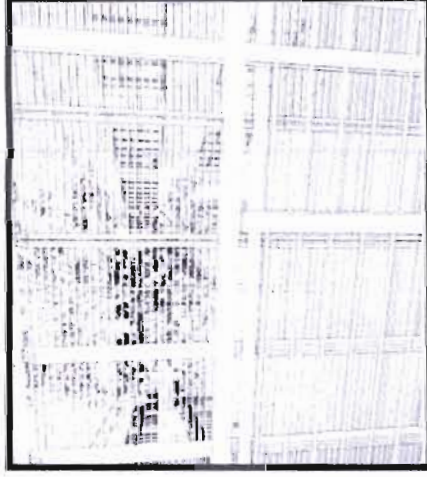




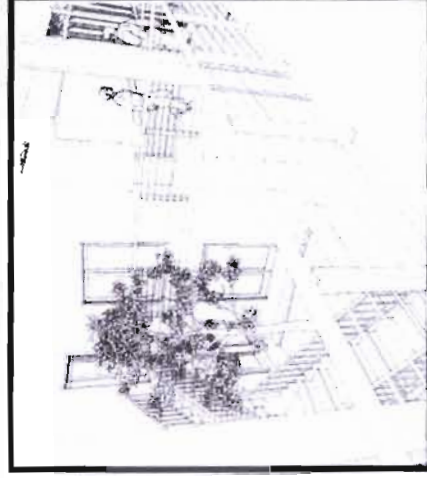
Perspective of reception and library



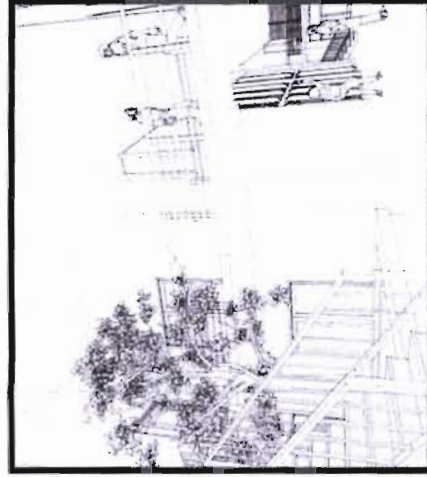
Perspective of interior stair from south end



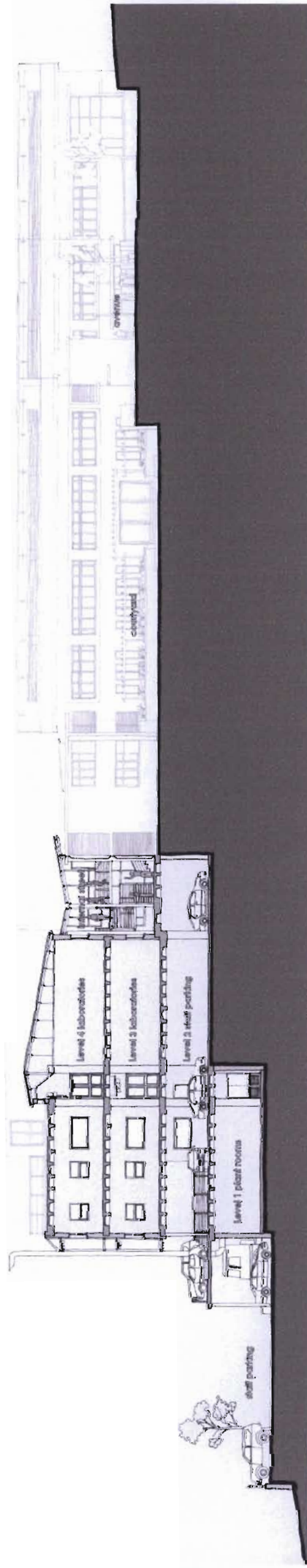
Perspective showing a courtyard through screen



Perspective showing stair recess with planter

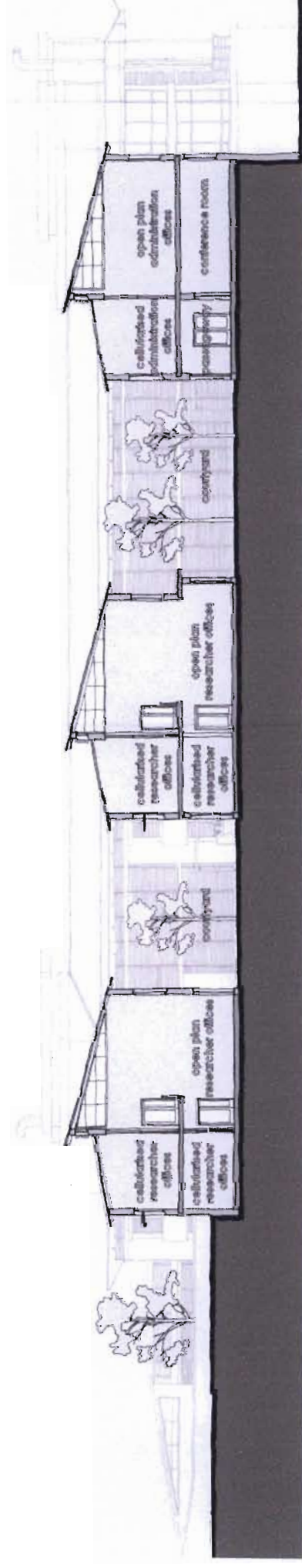


Perspective showing translucent roofing over tree



SECTION A-A

Scale 1:100

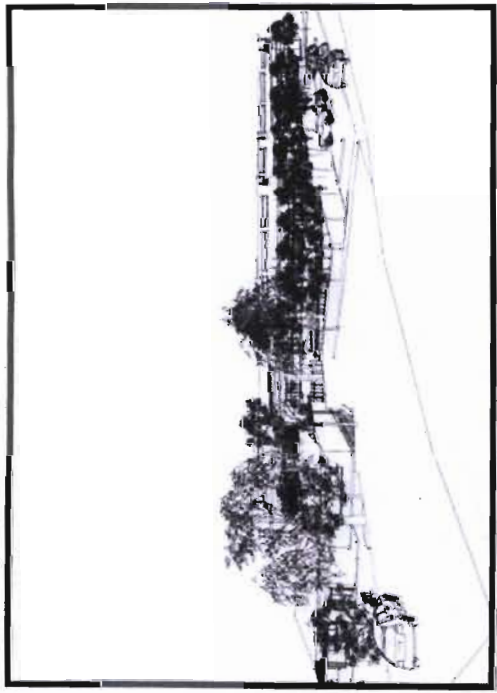


SECTION B-B

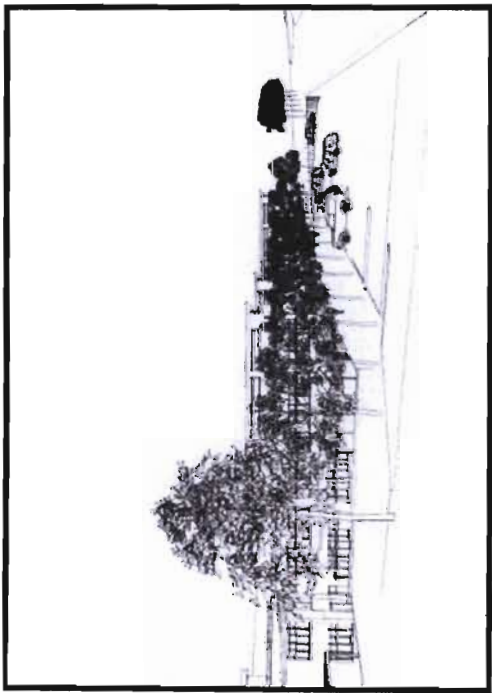
Scale 1:100

Cancer Research Institute and Laboratories

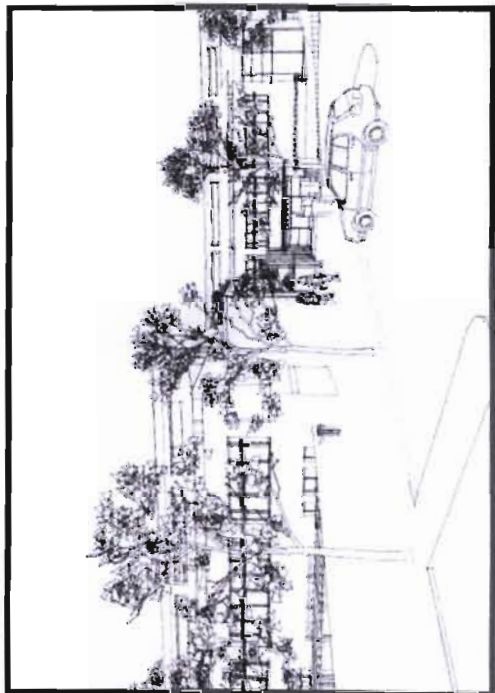




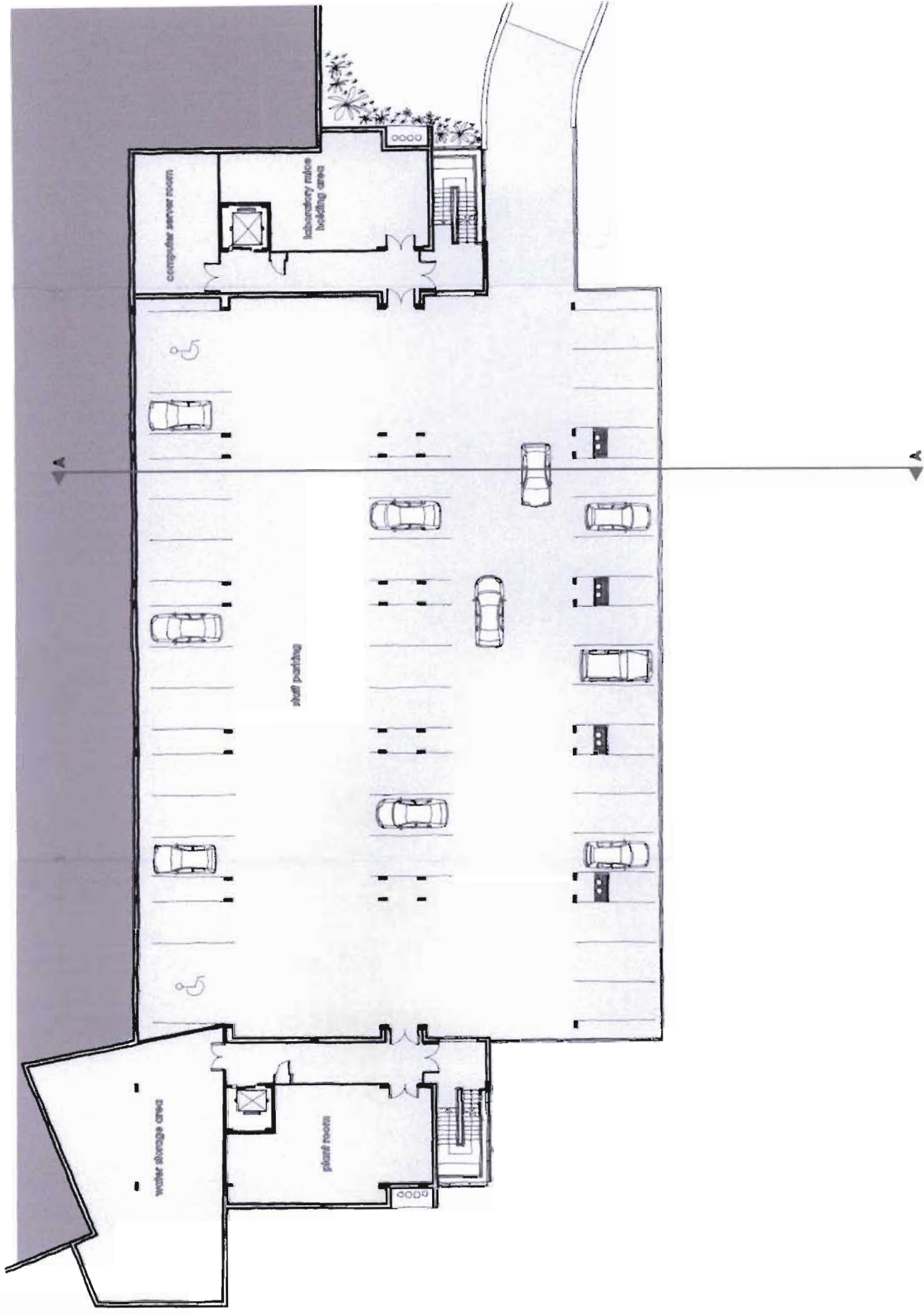
Perspective of Institute from Inhamat Hospital road



Perspective of walkway/ driveway as driving to park



Perspective showing entrance of building on avenue once parked

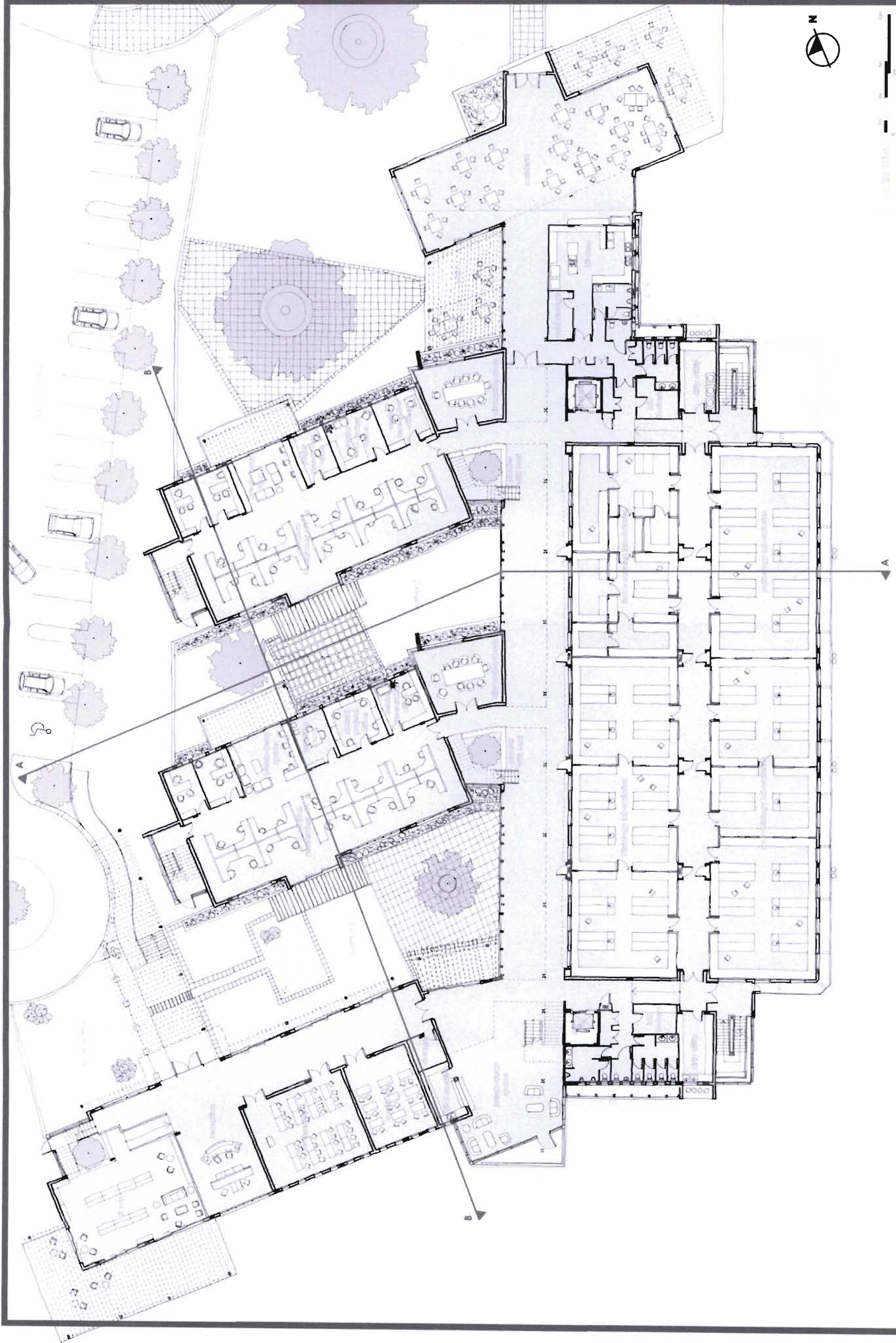


PLAN - LEVEL 2

Scale 1:100

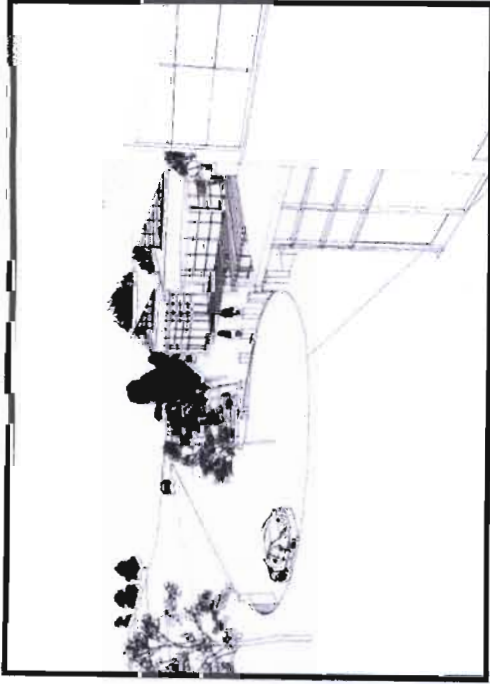
# Cancer Research Institute and Laboratories



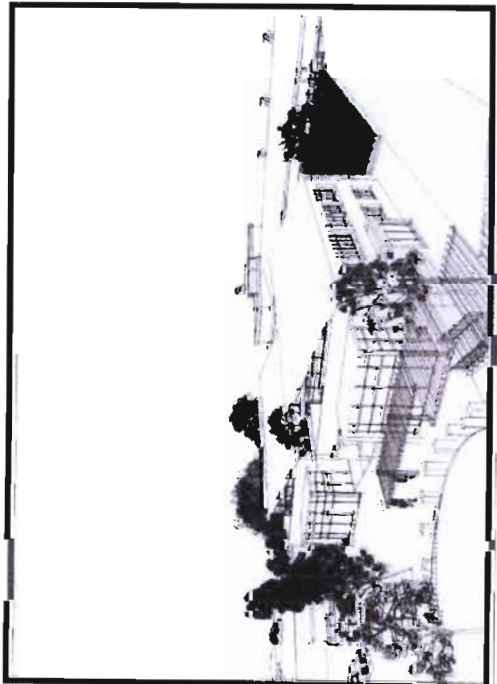


Cancer Research Institute and Laboratories

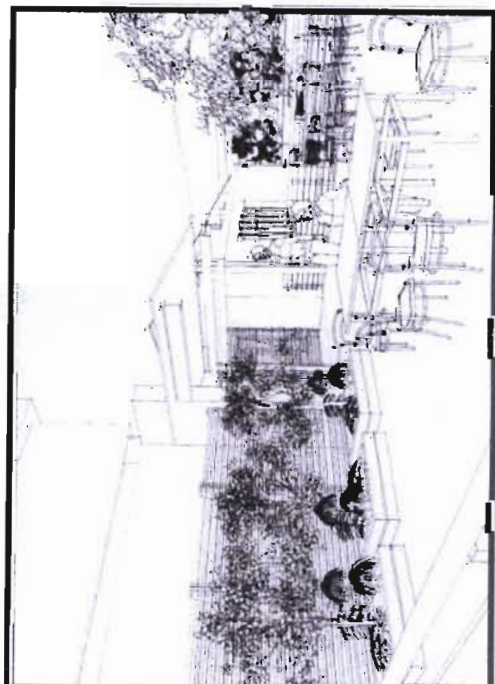




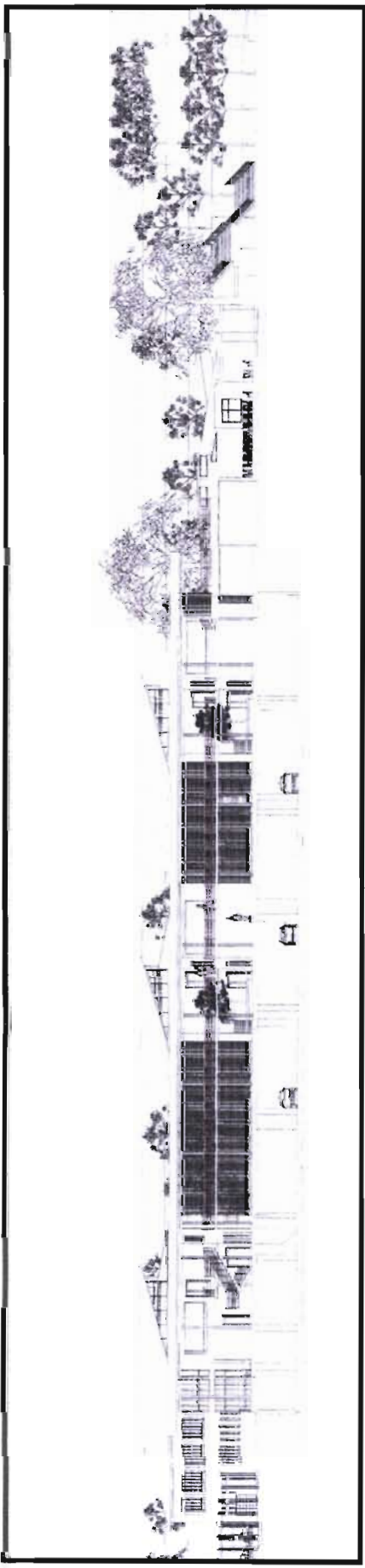
Perspective showing corner that certain glazing along avenue approach



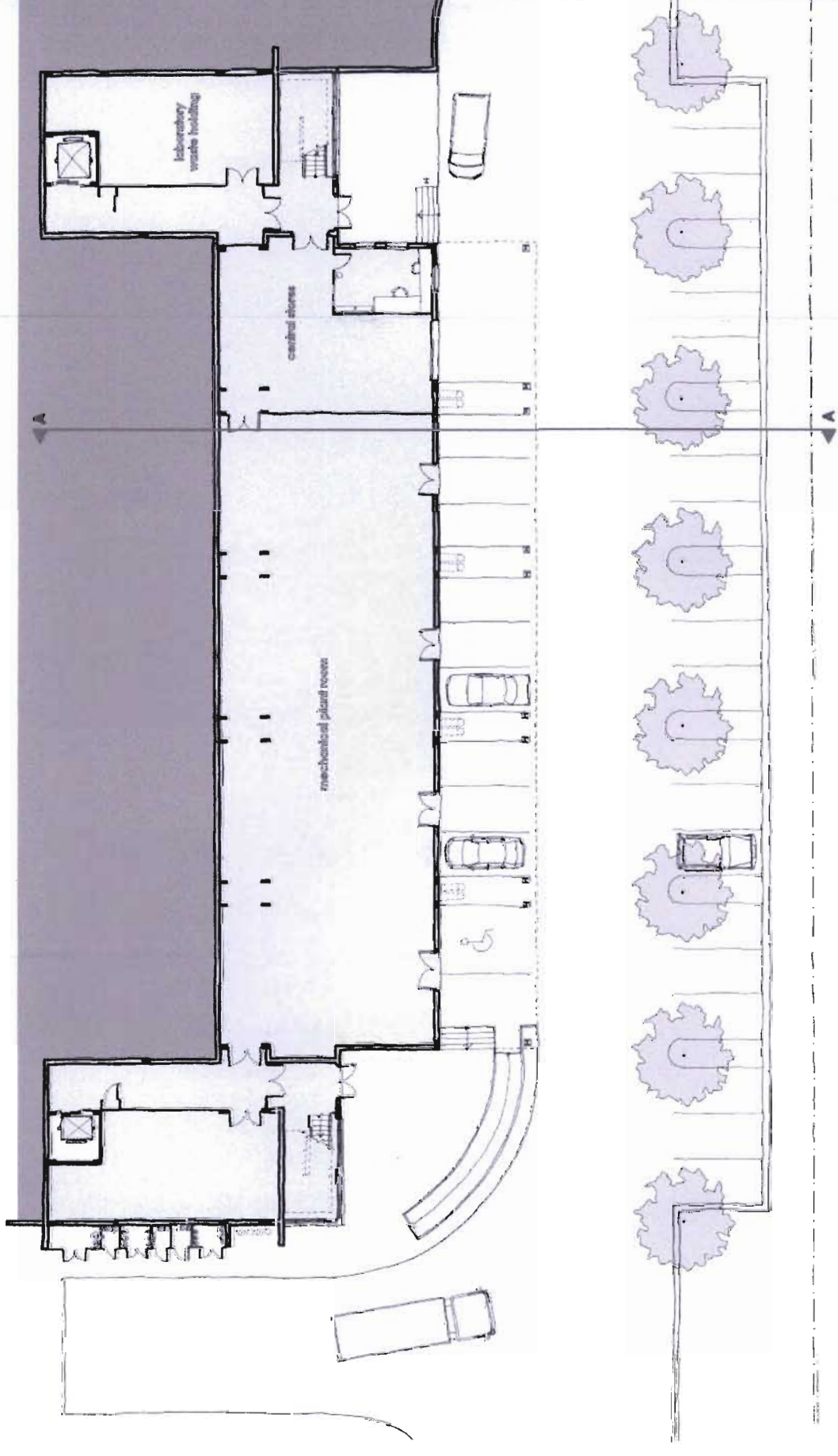
Axis perspective showing termination of driveway



Perspective showing upper level terrace



Sketch section along internal street

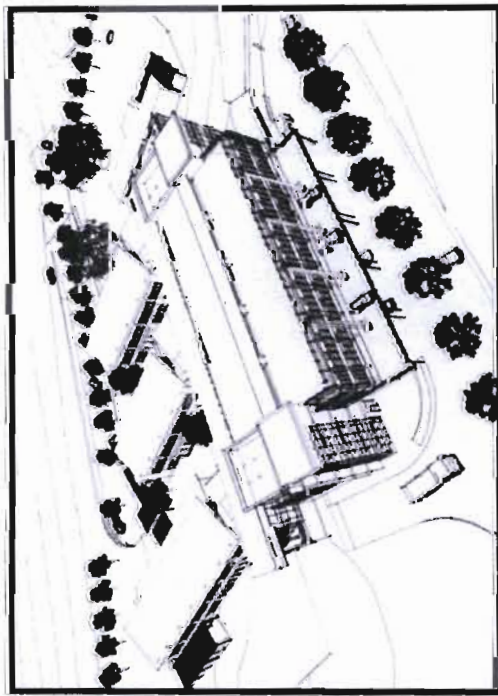


PLAN - LEVEL 1  
Scale 1:100

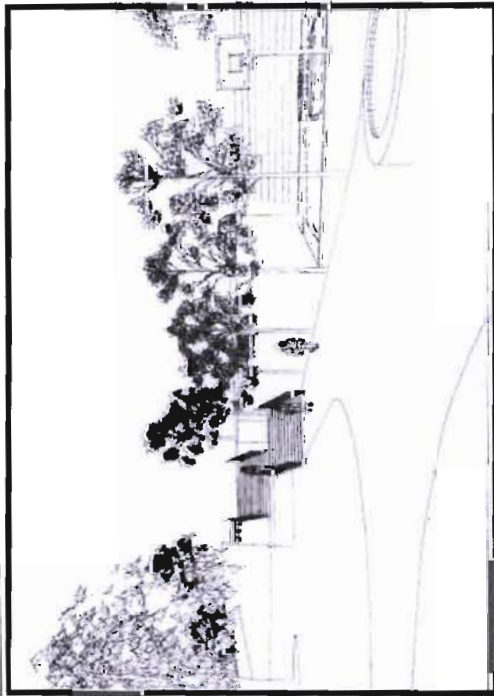


# Cancer Research Institute and Laboratories

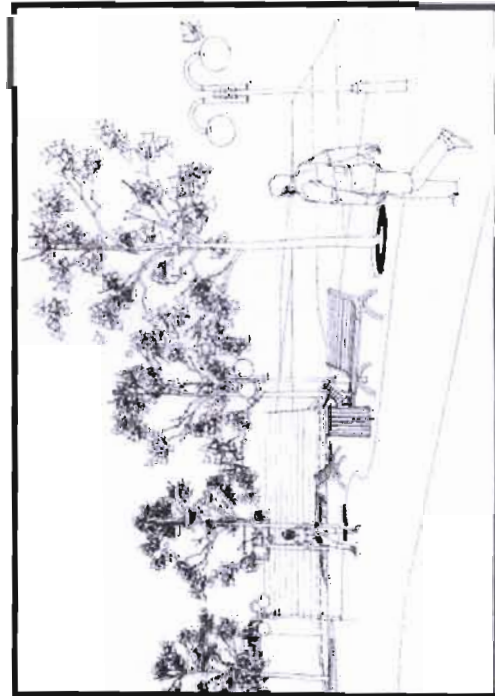




Artful view of Institute with major road facade in foreground

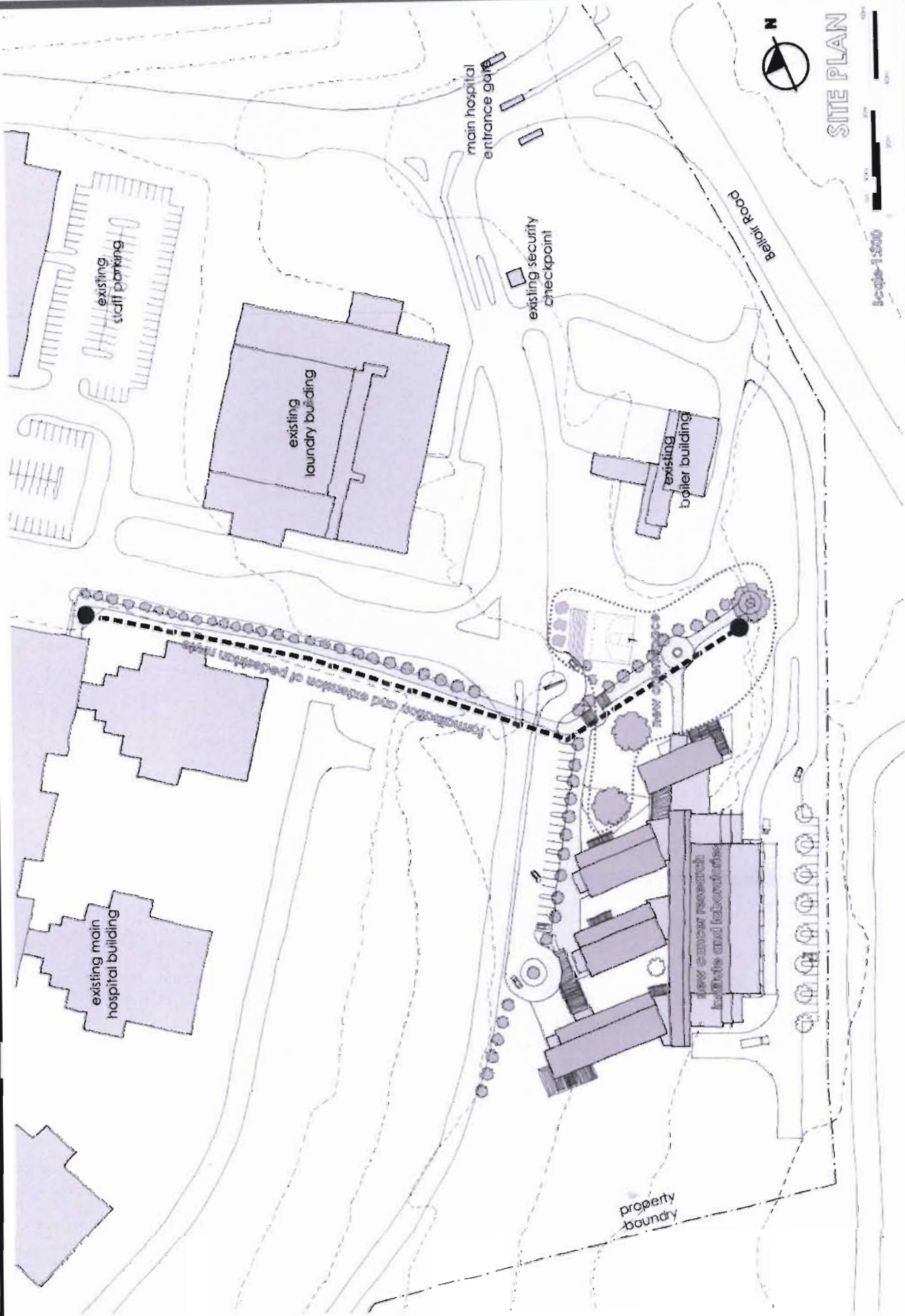
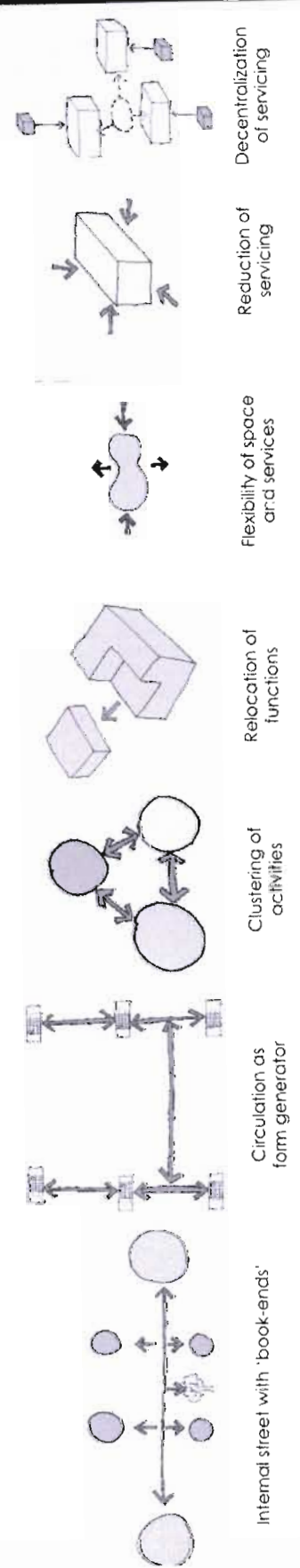


Perspective of open space with tree lined walkway



Perspective showing amenities provided by the open space

Design Concepts



Cancer Research Institute and Laboratories





### Site in its Context

**Location Plan**

**Context Plan**

**Connections**  
As shown in the Context Plan, the site is located on the eastern side of the road, adjacent to the main road.

### Analytical Precedents

**Section**  
Buffering  
Privacy gradient  
Slope of site to advantage.

**Section**  
Informal service space  
Verandah thus facilitates servicing.

**Site**  
Views  
Advantages of site

**Scale: Institute**

**Scale: Institute**

### Footprints

### Qualitative Precedents

**Informal street**

**Warmth**

**Services alignment**

**Warmth**

**Colour & Texture**

**Visibility**

**Nature / workplace**  
Qualitative evidence  
Integration of surroundings and nature with industrial language  
Consistency of language in elements

**Environment**  
Informal discussion approx  
visual connections

**Informal street as narrative**

### Site specifics

**Topography**  
Major earthworks on limited site opportunities  
Opportunities for bombing

**Noise**  
Beltar Road busy, generates noise along SE boundary  
Noise by functions in close proximity, but not acute.

**Visibility**  
Site visible from Beltar Road, but not competing with busy internal site traffic

**Urban Framework**  
Preliminary plans for possible extension along edge physically linking to main hospital building.

**Section A-A 1:1000**

**Section B-B 1:1000**

**Missing & future activation**

**Connections & noise sources**

### Climatic factors

**Direction**  
Most prevalent winds from NE / SW  
Winds with most velocity from NE (SW) show prevalence during the day  
Major exposure of building facing vector of least-wind

**Orientation**  
Slope facing SE  
Orientation seeks with light sensitive equatorward  
Overlapping down-hill tendency to increase floor plate depth

### Design Brief

**Site**  
Servicing  
Flexibility  
Planning  
Environmental

**Response**  
Humane environment  
Facility design guidelines

# Cancer Research Institute and Laboratories

**Laboratory servicing**

horizontal service strategy

service carrier

localised extraction

quick connects

integrated task and ambient lighting

service installation

**Impact reduction**

Controlled usage of natural daylighting

Building orientation

Computerised building management system

Reducing servicing

Solar water heating

Grey water harvesting

task and ambient lighting

**Air movement**

**Structural Resolution**

bench module

column grid

service runs

coffers

Parking

Planning considerations

Laboratory bench module

Potential Laboratory divisions

**Solar studies**

equinox 12h00

winter 14h00

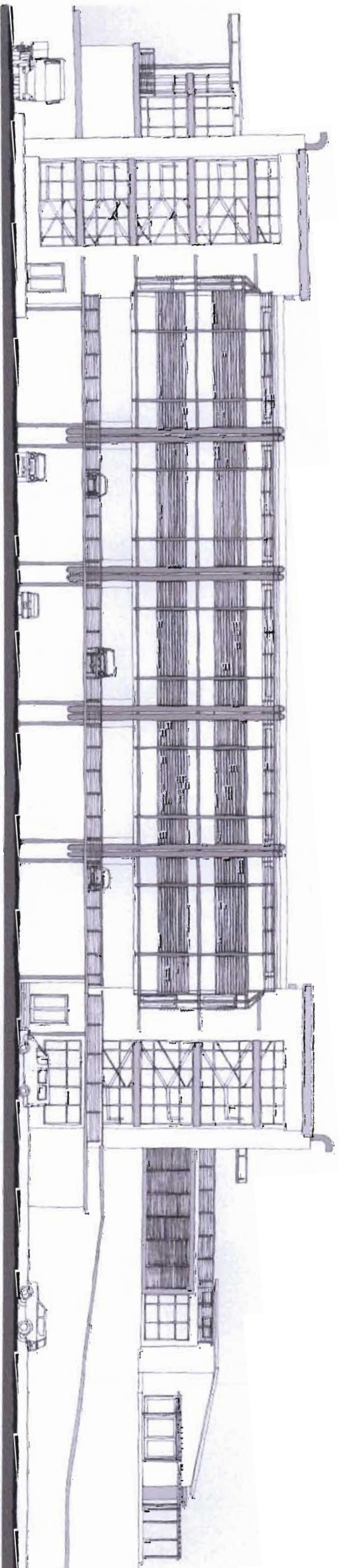
summer 07h00

equinox 17h00

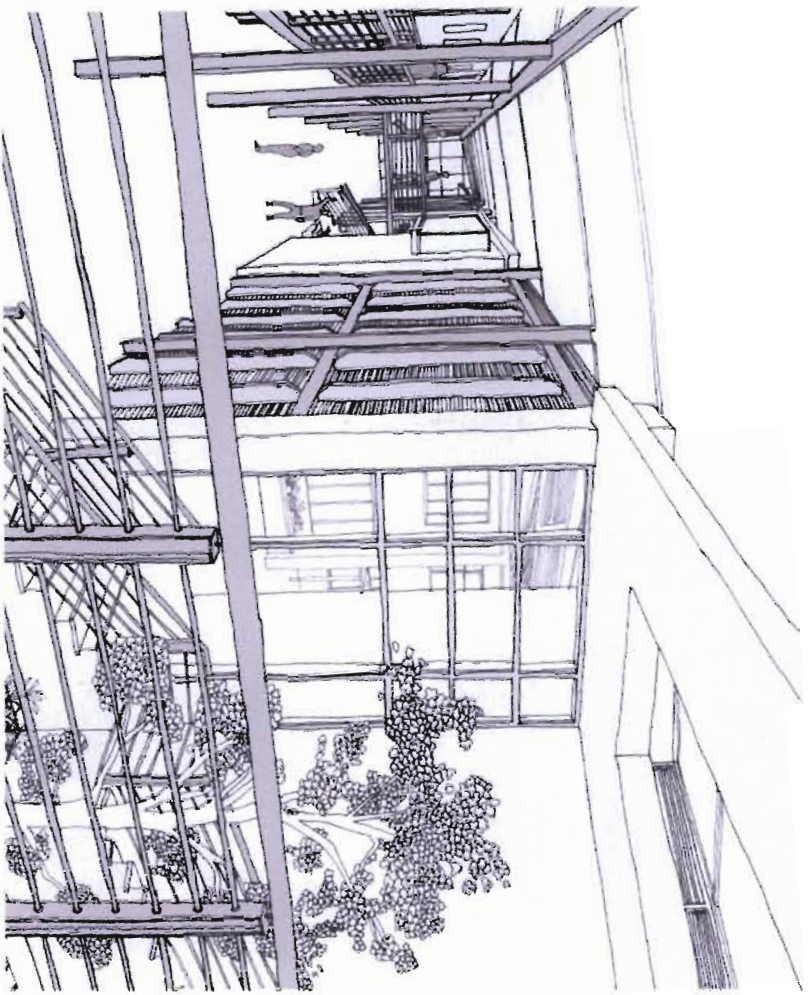
winter 15h00

summer 09h00

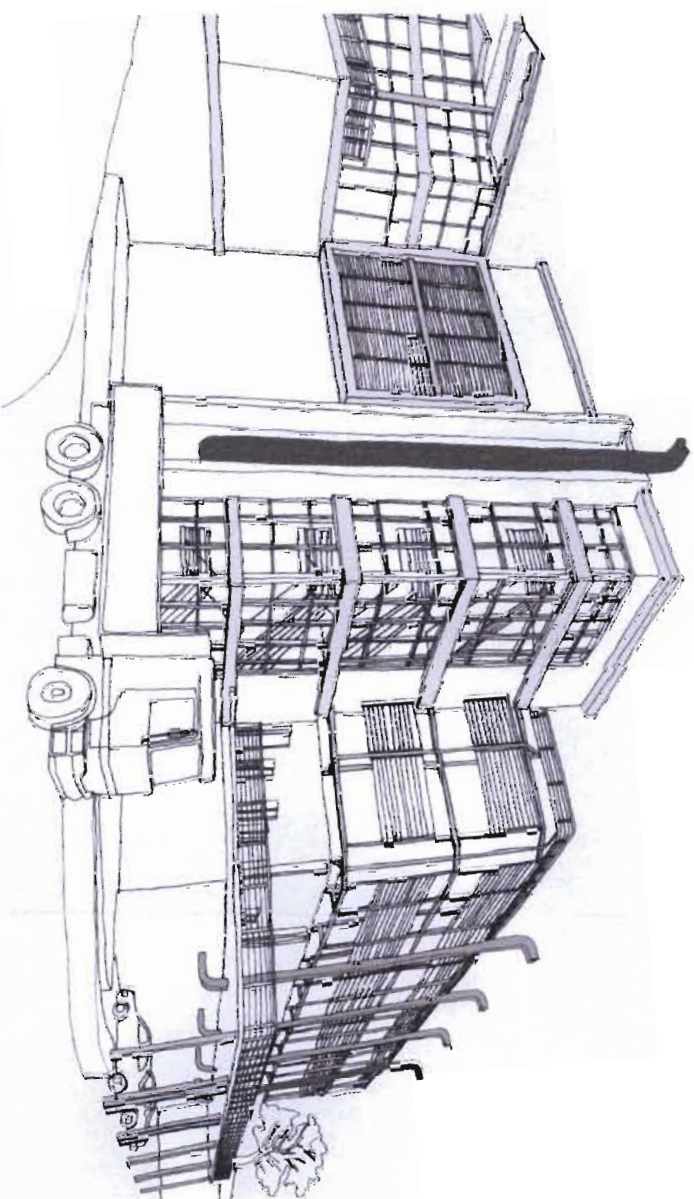
**Cancer Research Institute and Laboratories**



SOUTH ELEVATION  
Scale 1:100



Perspective showing internal street



Perspective showing major street facing facade and corner stairs



# Cancer Research Institute and Laboratories